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THE BRITISH SPECIES OF PSENINE WASPS (HYMENOPTERA : SPHECIDAE)

By G. M. Spooner, M.B.E., M.A.

(Communicated by Dr. O. W. Richards, M.A.)

Manuscript received 2nd April, 1947.
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With 5 Text-figures.

Since the publication of E. Saunders' work (1896) no special attention in Britain has been given to the Sphecid genera *Psen* Latreille, *Psenulus* Kohl, and *Mimesa* Shuckard. Particularly in *Mimesa* there has been a need for more critical descriptions, especially now that additional species have been recognised. Even for species which have long been known, determinations have been found to require closer study than the available keys might indicate. The opportunity has also been taken of bringing together information on their distribution in the British Isles and general biology. While our knowledge of the former has increased considerably during the past fifty years, that of the latter is still scanty. Attention is drawn to instances in which new observations are likely to prove of more than usual interest.

The section of the Sphecidae here considered is the Psenini (or Pseninae) *sens. str.*, which comprise slender forms with a petiolated abdomen, the petiole being formed by the anterior part of the first sternite ; with the male eighth sternite narrowed, curved and produced to a sharp point ; and (as opposed to the related Pemphredonini) with three cubital cells in the anterior wing. All species prey on Homoptera, constructing their cells either in ready-made cavities in timber or plant stems, or in burrows in light soils. Some species are unobtrusive in their behaviour and apt to elude observation.

There are two important modern contributions on the taxonomy of these wasps. North American species have been revised by Malloch (1933), and palaearctic species by de Beaumont (1937). For information referring outside the British Isles much reliance has been placed on these works, as, for example, acceptance of the general validity of the generic and subgeneric characters given below. Gussakovskij's (1937) independent treatment of palaearctic species has not been studied by the writer, but any points which bear on west European species are dealt with in de Beaumont's (1941) comments on the work.

The present contribution grew out of an article of much more limited scope. Dr. O. W. Richards, however, very generously passed over to me various unpublished notes, including the biological data (for the species here concerned) which he had assembled for a possible future contribution on those Sphecid genera which were not included in the publications of Hamm and Richards (1926, 1930). His material included both original data and extracts from literature to which I had not ready

access. It was thus possible to attempt a full review of all the British species of the group. In collating observations on habits, I have deliberately emphasised those made in this country.

From what has just been said it is clear that I am under considerable obligation to Dr. Richards. I am also much indebted to Monsieur J. Bondroit, who supplied me with detailed information on the species of black *Mimesa* he discovered in Belgium, and so helped to clarify the present available knowledge of this rather difficult group, as well as to Mr. H. M. Hallett for having forwarded to me examples of the black *Mimesa* from Glamorgan, and to Mr. A. W. Stelfox for having lent me the only available Irish specimen of the subgenus.

Data are quoted from specimens which have been examined from time to time in public and private collections, or in material sent to me for naming. I have pleasure in recording acknowledgements to Messrs. R. B. Benson and J. F. Perkins (British Museum (Natural History)), Prof. G. Hale Carpenter and Dr. B. M. Hobby (Hope Dept., University Museum, Oxford), Mr. G. J. Kerrich (Manchester Museum), Mr. E. A. Ellis (Norwich Museum), the late H. P. Jones (Wollaton Museum), the late H. L. Andrewes, Dr. C. D. Day, Mr. K. M. Guichard, the late Rev. A. Thornley, and Dr. I. H. H. Yarrow. I also quote from manuscript notes kindly given me by Dr. R. C. L. Perkins and Mr. O. H. Latter.

Key to Genera and Subgenera.

1. Head with exceptionally well developed facial and frontal carinae, which tend to take on a specialised form (fig. 2). (Facial carina transverse, bounding the antennal insertions anteriorly ; frontal carina median, extending from anterior ocellus between antennae to connect with mid-point of facial carina.) Frontal carina expanded and sulcate at least at the level of the antennal insertions. Cubitus of posterior wing arising distad of junction of median transverse nerve (fig. 1*e*). Stigma of anterior wing large, rounded apically. Tibial spurs, especially in male, long and sharp. Anterior trochanters and basal third of femora in female flattened on ventral surface. (Petiole short. Typically second and third cubital cells each receives a recurrent nerve.) . *Psenulus* Kohl

   If either facial or frontal carina present, it is a simple finely raised line or represented by a small tubercle. Cubitus of posterior wing arising proximad to the junction of median transverse nerve (fig. 1*f*). Tibial spurs not abnormally attenuated. Stigma normal. Anterior legs of female simple 2

2. Abdomen of male with soft fasciculate hairs at apex of at least sternite 3, the hairs prominent, projecting ventrally. In this sex other specialisations may be present—*e.g.*, in the antenna and basitarsus 2. Second recurrent nerve meeting base of third cubital cell, or interstitial. Petiole lacking series of piliferous punctures along latero-dorsal angle. (Dorsal part of mesopleuron smooth and shining, clearly separated from lower part by a transverse suture. Median frontal carina wanting, but either a tubercle present between antennal insertions, or a strongly raised carina

unites the lower margins of the antennal insertions. Petiole long, dorsally flat) . . . . . *Psen* Latreille[1]

Sternites, antenna, and basitarsus 2 of male without specialisations. Second cubital cell receiving both recurrent veins (fig. 1*d*). Petiole bearing hairs latero-dorsally . . . *Mimesa* Shuckard 3

3. Dorsal part of mesopleuron dull and distinctly sculptured—striate or striato-punctate. Transverse suture separating dorsal and ventral parts of mesopleuron feebly developed. Frontal carina of head absent, or almost so, but at least represented by a small tubercle between the antennal insertions. Clypeus with a transverse tubercle near anterior border. Usually basal tergites coloured with red (always so in species treated below). Petiole sometimes convex dorsally, but without distinct dorsal carina or lateral sulci. (Pygidium rather broad, bounded by a fine raised line, unspecialiséd, closely punctate)
subgenus *Mimesa* Shuckard (*sens. strict.*)

Dorsal part of mesopleuron glossy and smooth, impunctate, or with only very fine scattered punctures, separated from ventral part by a distinct transverse suture. Frontal carina of head distinct and complete. Tubercle between antennal insertions lacking, but latter are joined anteriorly by a fine raised line (*i.e.*, a simple short transverse facial carina). Clypeus simple, lacking tubercle anteriorly. Petiole with distinct raised carina, flattened at least anteriorly, sometimes excavated posteriorly, and bounded by a pair of lateral sulci. Abdomen entirely black. (Form of pygidium variable) . . . . . subgenus *Mimumesa* Malloch

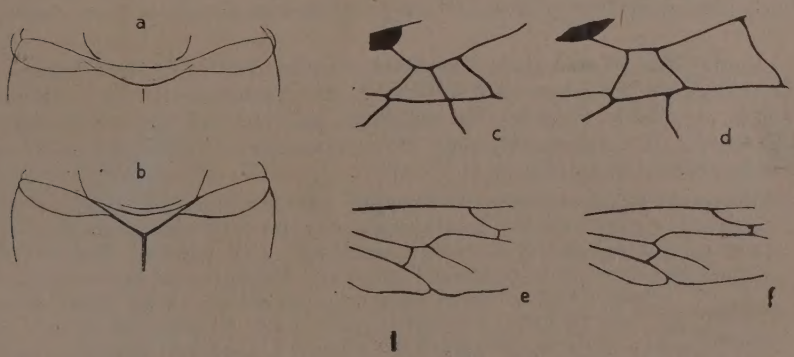

Fig. 1.—Anterior carina of mesosternum in (*a*) *Mimesa unicolor* ♂, (*b*) *M. dahlbomi* ♂. Cubital region of fore-wing in (*c*) *Psenulus atratus*, (*d*) *Mimesa equestris*. Venation of hind-wing in (*e*) *Psenulus atratus*, (*f*) *Mimesa equestris*.

[1] Some of these character definitions would have to be modified if *Mimesa exarata* Eversmann, 1849 (= (?) *superba* Tournier, 1889 ♀) is to be included, as de Beaumont tentatively does, in this genus. The species, if indeed a single species is involved, seems to be of anomalous status (de Beaumont, 1937 : 44–45). Possibly a separate subgenus of either *Psen* or *Mimesa* is required to include it.

PSENULUS Kohl.

Psen André, 1886 ; E. Saunders, 1896 ; Berland, 1925 : 129–132, figs. 231–238.
Psenulus Kohl, 1896 ; E. Saunders, 1906 ; Richards, 1935, 1937 ; de Beaumont, 1937 : 76–91, figs. 2, 37–49.
Neofoxia Viereck, 1901.
Diodontus Rohwer, 1915 ; Malloch, 1933 (*nec* Curtis, 1834 : see Richards, 1935).

Rather small black species with a short petiole, characterised particularly by the unusual development of the occipital carinae, which are at most represented by simple lines or small tubercles in related genera. The males are at once distinguished by their longer antennae, which scarcely increase in breadth towards the apex, and the segments of which are so rounded as to be broader in their middle than at their ends. The shorter antennae of the female are markedly clavate. Tergite 7 in the male is scarcely visible.

Psenulus make their nests in hollow stems of various kinds, in holes in wooden posts, and sometimes in other types of ready-made cavities, preying on small Homoptera Sternorrhyncha (*e.g.*, APHIDIDAE and PSYLLIDAE).

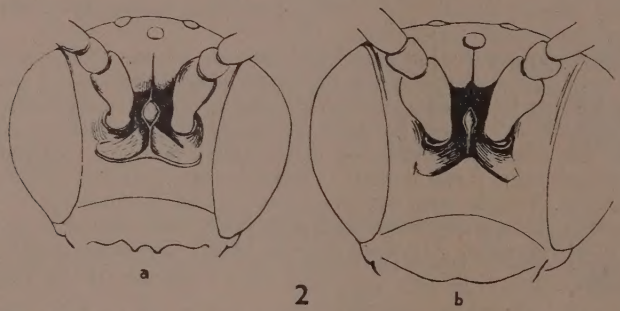

FIG. 2.—Face of *Psenulus* (*a*) *atratus*, (*b*) *concolor*, to show the form of the fronta carina.

It may still be uncertain how many species exist in western Europe, the taxonomy being rendered difficult by the variation to which certain species are liable, and by the smallness of some of the interspecific differences. But apparently only two species occur in Britain, and are readily separated as follows :

Transverse facial carina with its right and left branches (each slightly curved) almost in a straight line, met by the median carina well below the antennal insertions so that together they make the shape of an inverted T (fig. 2*a*). Expansion of median carina between the antennal insertions prominent, raised into a subquadrate tubercle, excavated on its disc. Clypeus closely punctured ; anterior margin with clear-cut U-shaped central emargination. Vertex anterior to the ocelli, though somewhat shining, with distinct sculpture, shallowly punctate in ♀, striate and punctate in ♂. Sternite 2 in ♀ bearing on its basal half a shallow depression of parabolic shape, clearly margined ; in ♂ a weak development of this structure quite evident if a clear view of the sternite is obtained, but the feebly raised margin altogether obsolete apically. Longitudinal impressions of mesonotum short. Apical sternites of ♀ with decumbent apical fringes of pale or brownish hairs. Smaller species (5–7 mm.)

atratus (Fabricius)

Transverse facial carina with its right and left branches oblique, meeting almost between antennal insertions and forming nearly a right-angle (fig. 2*b*). Expansion of median carina not strongly raised, simply grooved. Clypeus shining, weakly and remotely punctured ; anterior margin with very feeble central emargination. Vertex anterior to the ocelli smooth and polished. Sternite 2 in ♀ flattened centrally at base, but this area lacks continuous margin. Exterior pair of longitudinal impressions of mesonotum long. Apical sternites lacking apical fringes in both sexes. Rather larger species (6–8 mm.) . . . . . *concolor* (Dahlbom)

Psenulus atratus (Fabricius) (*pallipes* auctt.)

Trypoxylon atratum Fabricius, 1805.
Psen pallipes E. Saunders, 1896 ; Berland, 1925 : 131, figs. 232, 238 (? *nec Sphex pallipes* Panzer, 1798).
Psenulus pallipes Kohl, 1896 ; E. Saunders, 1906 ; de Beaumont, 1937 : 85–88, figs. 38, 41, 46, 48.
Psenulus rubicola Harttig, 1931.
Psenulus atratus Richards, 1935, 1937.

Though differing in several respects from *concolor*, *atratus* is much closer to another common continental species, *fuscipennis* Dahlbom, which, however, has the vertex more strongly sculptured, usually both recurrent veins meeting the base of the second cubital cell, and the pygidium of the female broader.

The two sexes differ in various characters. In addition to the distinctions in the antennae, and in the shape of the anterior legs which are flattened at the base in the female, the male has the transverse facial carina more raised from the face, the margined depression on sternite 2 somewhat obsolete, the vertex more striate, and the sternites without apical hair fringes.

This species is widely spread in England and Wales, and extends into Ireland. It has been recorded from the large majority of vice-counties in the southern half of England, to Hereford, Worcs, Warwicks, Leics, Northants, and Norfolk, usually noted as common and generally distributed. From the northern half of England it is recorded as follows : N. Lincs : Old Bolingbroke (Graham, 1941). Notts : common and generally distributed (Carr, 1916, 1935). Cheshire : Birkenhead and Bowden (W. Gardner, 1901), Wilmslow (Kloet, 1941). S. Lancs : Manchester (W. Gardner, 1901). Yorks : all vice-counties except N.W. (Butterfield and Fordham, 1932). Westmorland : Milkenthorpe (*Britten* : coll. Manchester Mus., *teste* G.M.S.). It probably occurs throughout Wales, though recorded from only two counties : Glamorgan : common (Hallet, 1928). Merionethshire : Fairbourne (Kloet, 1941). Irish localities given by Stelfox (1927, 1933) occur in Wexford, Wicklow, Dublin, Queen's Co., and Roscommon. It is unknown in Northern Ireland and Scotland.

Emergence.

P. atratus is on the wing in mid-summer, and is evidently single-brooded in Britain, except for possible sporadic second emergences. For the male early dates are May 25th (Dorset, 1927) and May 29th

(Leics, 1944), but usually emergence in numbers is not to be expected much before mid-June. Many were flying on June 15th, 1940, at Wood Walton Fen, Hunts. A series of 53 examples from Wotton, W. Glos (coll. *V. R. Perkins*) was taken between June 16th and July 6th, about half the total on 27.vi.85 and 28.vi.83. Dates from Ireland (Stelfox, 1927, 1933) are appreciably later : those for at least seven males recorded fall between July 12th and August 14th. For the female, 63 dated specimens from England were taken between June 13th and August 14th, except one on August 24th (Dorset, 1941) and one in the Dale Coll. labelled September 12th (Dorset, 1870). Such exceptionally late dates may indicate an occasional second generation : 1941 at least was a favourable season. Around Paris, however, two generations are regular (Chevalier, 1925).

Biology : Introduction.

References to habits are more numerous than for any other Psenine. Nesting-sites are now well known to be ready-made cavities both in dead wood and timber and in hollow plant stems, including the straws of thatch on buildings. The prey is typically, perhaps entirely, of APHIDIDAE.

Modern observations are adequate to supply the main details of our present knowledge, but some points from earlier publications are of interest. Thus Kennedy (1837, quoted by Westwood, 1840 : II, 196) found this species nesting in the straws of thatch and provisioning its cells with aphids. As many as a hundred examples of the prey were found packed in some of the cells (but this number now seems unusually high). The white and semitransparent egg was attached to the abdomen of an aphid at the bottom of the cell. Probably this also was the "*Psen caliginosus*" of Hewitson (1838), who found it swarming at the thatch of an old summer-house near Bristol. Many straws were opened and a few of them yielded examples of the Chrysidid *Hedychrum bidentulum* [=*Omalus aeneus* (Fabricius)] distributed singly in the nests.

Amongst the writings of J. H. Fabre (1886, 1903), two original references are made to *P. atratus*, which first received attention as a coloniser of hollow bramble stems (*Souv. Ent.* 3 : 391). An attempt was made to investigate the distribution of the two sexes amongst the brood, but heavy parasitisation by an Ichneumonid, *Ephialtes mediator*, made this difficult. Only three unbroken series were obtained, producing 8 females, 6 females, and 8 males respectively. At this time Fabre was familiar with *P. atratus* as a predator of aphids. Later (*Souv. Ent.* 8 : 225) it is introduced as a predator of one infesting the turpentine tree (*Pistacia terebinthus*). These aphids have to be extracted from the galls they produce, a feat which was accomplished by the wasp with remarkable rapidity. Fabre mentions here that the cells are sometimes stocked with JASSIDAE ("cicadelles"), an observation which is still in need of confirmation.

In reviewing continental publications, the possibility of incorrect determinations has always to be borne in mind, especially amongst the older references. Thus Tischbein (quoted André, 1886 : 185) gives *Psyllus alni*, taken on leaves of alder, as the prey. There is no confirma-

tion that PSYLLIDAE are really taken by *P. atratus*, except for a single doubtful record (Giraud, 1929).

Nesting sites.

Borries (1897) states that the species normally inhabits old woodwork, quoting that nests were once found in decayed willows. In Britain, V. R. Perkins took it round dead elm wood at Wotton, W. Glos (Saunders, 1896), evidently in some numbers, judging by the long series which survived in his collection. Morice (1897) states he had taken the wasp at palings as well as at mud-walls and thatch. Stelfox (1927) refers to it frequenting tree-stumps and other bored timber in Ireland.

My own observations indicate that woodwork is often frequented in this country. Near Weymouth, Dorset, several females were observed entering holes in a gate-post, 6.vii.45 ; in the Tavy Valley, S. Devon, three were taken at holes in the dead trunk of an alder, 28.vii.45 ; single females have also been taken at wooden posts in another Dorset and two Cambridgeshire localities. In Charnwood Forest, Leics, timber seemed to be used much more freely than plant stems, females being observed on various occasions at holes in dead tree-stumps, exposed wood of felled trunks, or gate-posts, whereas only three nests altogether were found out of a large number of plant stems tenanted by aculeates.

Hollow plant stems, however, are very generally used, and the records display an interesting variety of sites. Fitch (1880 : 261) gives *P. pallipes* among species bred from old galls of *Cynips kollari*, two specimens having been thus secured by Weston. Parfitt (1880 : 27) reared it from bramble stems in S. Devon. Mr. O. H. Latter (MS. notes) has observed it at stems of *Viburnum* in Surrey.

A nest in a withered rose stem is described by Nielsen (1900 : 269), and one in a dead raspberry stem is recorded by Adlerz (1912). Baer (1901 : 161) mentions nesting in hollow twigs. A further instance is given by Descy (1922 : 94), who found a female "*Psen pallidipes* (Panzer)" provisioning cells in a stake supporting a young rose bush, and describes a simple homing experiment which showed that the wasp "memorised" the position in space of the mouth of the burrow. In the more detailed observations quoted below the following nesting sites are involved : straws and thin hollow bamboo canes (Chevalier, 1925) ; reed stems hanging from the branches of a pear tree (Harttig, 1932) ; straws of thatch forming the roof of a summer-house (Freeman, 1938).

Below, also, I give particulars of a nest in a dead woody elder stem from Charnwood Forest, Leics. I have also observed the wasps in abundance at the thatch of the hut in Wood Walton Fen, Hunts, 15.vi.40, and confirmed the presence of nests in the straws.

It is thus clear that *P. atratus* uses a great variety of ready-made cavities in dry vegetable structures, whether natural or artificial. The site chosen always seems to be above ground level. Cavities appear to be unsuitable if the diameter is less than 2 or greater than 3 mm. The wasp has not been observed to occupy burrows in the earth of vertical banks, as, for example, does *Trypoxylon figulus* (L.).

Further nesting habits.

Many interesting details are given by Chevalier (1925), who is the first observer since Fabre to have given *P. atratus* special attention. In the Paris area the nesting season extends from the end of May to October, involving two generations. Wasps may continue provisioning nests after sundown, or in stormy weather, if warm. The prey was always found to be aphids, of which 25 to 30 are stored in one cell: sometimes all one species, sometimes several mixed. When carried the prey was held close to the wasp's body, belly uppermost, clasped by the wasp's mid legs (a habit, incidentally, which it shares with *Mimesa*, but not *Mimumesa*). The cells were 5–6 mm. long. The egg was observed to be white, cylindrical, 1 mm. long, and to be attached flat on the side of one of the last few aphids stored. In one cell examined the egg, laid on October 1st, hatched four days later: the larva took nine days to finish its stock of prey. A single wasp was never observed to use more than two nesting tubes—unlike other stem-nesters: the complete lay was estimated at 12–14 eggs. When her eggs are exhausted the female remains in the completed nest, her back against the last cell barrier, without constructing an outer barrier to the nest. The winter is passed in the larval state, pupation occurring in May, and emergence two or three weeks later.

The cells of the wasp studied by Descy (*loc. cit.*) were found fully stocked with aphids; as were also nests opened by Grandi (1934 : 74) and Harttig (1932). Grandi's nest, in a reed, consisted of twelve cells, most of which contained larvae. Harttig's contained nine cells, separated by thin partitions described as "membranous," the terminal cell still not closed: there were from 15 to 29 aphids per cell, making a total stock of about 200. Among them the following species were identified:—

> *Amphorophora rubi* Kaltenbach (nymph, wingless female). *Aphis sambuci* L. (larva, nymph, winged and wingless female). *Chromaphis juglandis* Goeze (larva). *C. juglandicola* Kaltenbach (larva, nymph, winged female). *Doralis fabae* Scopoli (wingless female). *Macrosiphon zei* Koch (larva, nymph). *Myzodes persicae* Sulzer (larva). *Yezabura* (*Anuraphis*) *maligolii* Fitsch (*discrepans* Koch).

The first cell contained a full-fed larva, the next three growing larvae, and the next four were still with eggs. Each egg was attached to one of the aphids ventrally behind the first pair of legs.

In Britain the first accurate details of nest-contents are those of Freeman (1938). Particulars are given of seven nests, taken from thatch on 27 and 28.viii.36, near Slough, Bucks. The number of cells in any one straw was evidently limited by the position of the first node, beyond which no cells were found. In one straw there were six cells complete and the start of a seventh. Cells were 7 to 10 mm. long, in cavities of 2–3 mm. diameter. Partitions between cells were very thin and formed from particles of straw. The prey, as usual, consisted entirely of aphids, the majority nymphs, and all specimens dead. The highest number observed in one cell was 36, and the lowest among those fully stocked

was 21. A summary of the species of prey, and the total numbers, is as follows :—

> *Amphorophora cosmopolitanus* Mason, 67 nymphs, 35 adults ; *Aphis* sp., 26 nymphs, 1 adult ; *Macrosiphum pisi* (Kaltenbach), 216 nymphs, 18 adults ; *Megoura viciae* (Kaltenbach), 103 nymphs, 11 adults ; *Myzocollis tiliae* (L.), 21 nymphs, 1 winged adult ; *Myzus* sp., 1 adult.

The two most numerous of the above are both found on leguminous plants. In these nests the egg, one of which measured 1·3×0·25 mm., was found in various positions in the cell, from the inner to the outer end, and so may sometimes be laid at the start of provisioning. The larvae when fully fed were observed not to spin cocoons, but merely to spin silky membranes across the partitions and around the interior wall of the straw. Pupation took place in the spring.

Richards (unpublished) adds some data from the same site. A straw, entered by a female bearing prey, 8.viii.30, contained two complete cells, 9–10 mm. long, and 2·5 mm. in diameter, and one just started. Cell partitions were of pith, 0·5 mm. thick. The prey consisted of wingless aphids.

So far the observations quoted are in close agreement, or mutually consistent. They indicate strongly that the prey is confined to Aphididae. Consequently some doubt should perhaps be attached to the identity of the nest described by Micheli (1930 : 56–61) from N. Italy. It was attributed to *Psen pallipes* (Panzer) ; but the parent wasp was not seen. Three cells contained grown larvae, which are illustrated and described in some detail, while the fourth cell remained stocked with prey. The last consisted of two species of Psocidae : *Euclismia 4-maculata* (Latreille) and *Ellipsocus abietis* Kolbe. This observation remains unique.

My own unpublished observations on stem-nests are as follows. One collected early in 1942 at Woodhouse, Leics, produced adult wasps in early June. There were ten cells of which the first nine occupied a stretch of 48 mm., giving an average of 5·3 mm. per cell. The cavity was 2·9 mm. diameter below, narrowing to 2·5 mm. The three innermost cells, which were a little longer than the rest, produced females ; the fourth was empty ; the fifth, sixth, eighth, ninth and tenth produced males, while the seventh contained a dead pupa. Remains of aphid prey were seen. At this stage the original cell partitions were scarcely recognisable, but their position was marked by firm circular brown discs—the reduced cocoon "caps" (see below).

Two thatch straws, of diameter 2·5 mm., were collected at Wood Walton Fen, 15.vi.40, when many adults had emerged. These nests contained similar brown discs lying somewhat irregularly in the cavity, having evidently been pushed aside by the emerging wasps. In Charnwood Forest, Leics, two old nests in elder, each containing a single cell, were identified by the presence of aphid remains and a disc of the type described and of size appropriate for *P. atratus*. The diameters were 2·5 to 2·8 mm.

Though previous observers have remarked on the incompleteness of the cocoon, and Freeman (1938) describes its construction, it has not been appreciated that the disc-shaped caps to which the cocoons are virtually reduced are definite structures in *Psenulus*, and characteristic objects in their nests. They have been observed newly formed in *P. concolor*, which produces identical cocoon-caps (p. 142). The larva spins very sparingly and irregularly against the anterior part of the side walls, but makes a complete and firm membrane across the anterior end of the cell, against the original partition (which may already be collapsing). This disc-shaped membrane hardens and darkens after formation. It becomes brown, of chitin-like consistency, and smooth, though slightly roughened on its inner concave surface. Sometimes a short fringe of thinly-spun pale cocoon material, lining the cell wall, projects backwards from the margin of the disc; but more often the disc is virtually all that can be seen. The function of the cocoon is thus modified to forming a new cell-partition, which, in *P. atratus* at least, is a more efficient protection to the resting larva than the thin partition of loose fragments originally provided.

The emerging adult penetrates the cap after biting at its margin, breaking the attachment to the wall of the cell, and pushing the disc aside. The brown discs remain among the most persistent objects in old nests, and are diagnostic of *Psenulus*. They should not be confused with the original partitions, of resinous consistency (composed of macerated pith mixed with a varying amount of glutinous secretion), with which the female of *Passaloecus monilicornis* Dahlbom closes her cells, and which sometimes become discoloured to give a superficial resemblance.

Parasites.

The Chrysidids *Omalus auratus* (L.) and *O. spina* Dahlbom (=*Notozus bidens* Förster) are recorded by Chevalier (1925) in France. Perkins (1923) has suggested that *O. aeneus* (Fabricius) attacks *P. atratus*, both species having occurred freely together in gardens in S. Devon.

Fabre, as noted already, found heavy infestation by an Ichneumonid which he called *Ephialtes mediator*. Chevalier (1926) has studied the biology of the Ichneumonid *Perithous divinator* Rossi, an ecto-parasite of the larva of this and other stem-nesters. Chevalier (1930) also found the Chalcid *Melittobia acasta* Walker to occur as a hyperparasite on *Omalus auratus* in nests of *P. atratus*.

Though records from this country are lacking, it is probable that *P. atratus* is liable to attack by several hymenopterous parasites which are known to prey indiscriminately on various stem-nesting aculeates.

Other habits.

This wasp is little attracted to flowers. Records comprise single males at *Daucus* and *Euphorbia amygdaloides*, and females at *Heracleum*, *Pastinaca*, and *Rubus fruticosus*. Crèvecoeur (1927 : 38) reports an instance, in Belgium, of a cluster of seventeen males passing the night in the shelter of the foliage of a pear tree.

Psenulus concolor (Dahlbom).

Psen concolor Dahlbom, 1843 ; Morice, 1897 ; Berland, 1925 : 131, figs. 233.
Psenulus concolor E. Saunders, 1906 ; Richards, 1937 ; de Beaumont, 1937 : 79–81, figs. 37, 40, 43, 47.

This is a rather scarce species in Britain, but has proved to be much commoner than might be inferred from the small number of specimens that have been taken on the wing. Its presence in an area may be unsuspected until attempts are made at breeding it from hollow stems. The records of its occurrence are well scattered over southern England, and show that it is distributed westward at least to Devon and northward to Notts.

S. Devon : Bovey district, sparingly (*R. C. L. Perkins*). S. Hants : Brockenhurst, one in 1905 (Arnold, 1908). E. Kent : Dodington, one in 1896 (Chitty, 1903). Surrey : Byfleet, ♀, 14.vi.97 (Morice, 1897) ; Ockley, five reared from ash-stems (Nevinson, 1908) ; Box Hill, series of both sexes (probably reared) (*Nevinson*, coll. Hope Dept.) ; Ranmore Common, many of both sexes bred from ash-stems, collected 2.ii.26, adults emerging indoors April and May, 1926 (*O. W. Richards*). Herts : Chandler's Cross, ♀ (abdomen lacking petiole) emerged 27.v.27, and ♀ emerged v.28, both from nests in ash-stems (*O. W. Richards*). Bucks : Hedgerley, ♂ flying, 28.v.33 (*O. W. Richards*). Berks : Bagley Wood, ♀ bred from ash, emerged 29.iv.26 ; Cot Hill, ♀ entering hole in post, 6.vi.27 (*O. W. Richards*). W. Norfolk : King's Lynn, vi.05 and viii.07 (Atmore, 1909). Northants : Ashton Wold, ♀ 13.vii.22 (coll. N. C. Rothschild) (Spooner, 1935). Hereford : Tarrington, ♂ 18.vi.02, Tram Inn, ♀ 2.vii.02 (*Yerbury*) (E. Saunders, 1903). Notts : Oxton Bogs, 14.vii.15 (Carr, 1935). N. Lincs : Old Bolingbroke (Graham, 1941). E. Glos : Dover's Hill, Chipping Campden, February, 1946, three nests, from which 5 ♂ and 1 ♀ emerged, end iv. and early v.46 (*G.M.S.*). Leics : Woodhouse and Ulverscroft, Charnwood Forest, 1942 and 1944, several nests (see below) ; adults reared and observed round bushes close to nesting sites, end May to mid June (Spooner, 1946).

Biology.

The breeding habits are essentially similar to those of the preceding, with the following differences. There is a much greater preference for hollow stems as a nesting site : indeed nesting in dead wood may be quite exceptional. The prey consists of Psyllidae, perhaps exclusively. The size of cavities chosen for nests is larger. The cell partitions are firmer.

Giraud (1866 : 470–1) recorded *P. concolor* among 25 different species of aculeates hatched from hollow bramble stems. Nests in stems of ash and *Berberis* were found by Tournier (Morice, 1897), and Borries (1897) records nests in twigs of growing ash and elder, as well as in an old *Sesia* burrow at the base of a raspberry stem. Schütze (1921–4 : 114) bred the species from stems of raspberry and of *Salix caprea*, and from a branch of a lime tree.

In this country it has been reared from hollow ash stems by Nevinson (1908), and subsequently by Dr. Richards (records given above). Nests found by me in Charnwood Forest (Table I) were chiefly in dead stems

TABLE I.—Data on nests of *Psenulus concolor* Dahlbom, Charnwood Forest, Leics.

Serial No.	Date collected	Kind of stem	Diameter of cavity	Condition of nest	Number of cells	Length of cell (plus partition)	Prey	Other data
Q11	1.vi.44	Buddleia	2·5 mm.	Newly constructed, not completed. ♀ wasp, resting in the stem	1	11·5	Cell 1 with store of 16 Psyllid nymphs; Cell 2 partly stocked	Egg in middle of cell 1, attached to one of the Psyllids. Larva hatched and grew to full size.
Q18	12.vi.44	Buddleia	3·0	Do.	2	11·0, 9·5	Cell 1 with 24 psyllid nymphs; cell 2 with 14 Psyllid nymphs.	Newly hatched larva in cell 1.
L12	i.44	Elder	2·9 to 4·0	Full-fed larvae	9	av. 8·8	—	Stem kept indoors, and adults emerged during mid May. Bottom cell remained intact, with untouched store of Psyllids and complete partition.
W2	ii.42	Elder ?	3·5 to 3·8	Larvae; dead when examined	6 (min.)	av. 10·4	All cells with Psyllid prey	—
M1	29.v.44	Elder	3·5	Pupae (♀) and fresh adults (♂)	8	av. 9·5	—	Females emerged from cells 1 and 2, early June; males emerged from cells 4, 5, and 6.
M2	29.v.44	Elder	3·9 to 4·2	Do.	5	av. 8·2	—	Cell 1 with dead pupa; cells 2 and 3 gave females, 7.vi.; cell 4 also gave a female, and cell 5 a male adult.
M39	10.vi.44	Elder	4·0	Old	7	av. 8·4	—	One cell with Tachinid puparium (dead fly inside, not identifiable). This and the following easily recognised by the persistent cocoon-discs, etc.
M23	11.vi.44	Elder	3·0 to 3·3	Old	3	—	—	Base of nest 20·5 cm. from apex of stem.
Q17	7.vi.44	Buddleia	3·0	Old	6	av. 11·0	—	—
U5	ii.44	Ash	3·5	Old	2 (min.)	—	—	—
M3	29.v.44	Elder	4·0	Old, at least 3 yrs.	6 (min.)	—		Subsequent occupation by *Rhopalum clavipes* in upper part of stem.

of elder and *Buddleia*, some stout and woody, and nearly devoid of pith, some with fresh pith still present, in which a cavity had previously been bored by another insect. In 1946, at Chipping Campden, I found two nests in elder; of which one was in an old *Coelocrabro* burrow, and one in ash, in an old *Rhopalum* (?) burrow.

Knowledge of details of nesting habits is based on but three publications: Giraud (1866), Borries (1897), and Grandi (1937). I have recently, however, been able to confirm and supplement the continental observations from British material. Particulars of the nests examined, mentioned above, are set out in Table I.

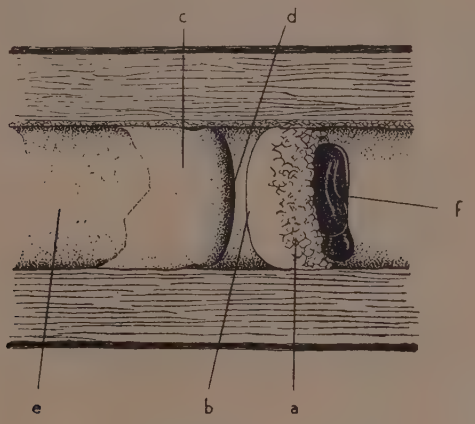

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Fig. 3.—Part of two adjacent cells in nest of *Psenulus concolor*. The hard part of the stem is sectioned away to expose the nest contents in profile. *a*, Cell partition composed of pith fragments, with, *b*, a smooth secreted membrane on its inner convex face. *c*, the anterior "cap" of a cocoon, of which the terminal part, *d*, forms a solid disc, and which posteriorly, *e*, merges into a thin lining applied to the cell wall. (The irregular posterior border of *c* shows where the cocoon cap has broken away from that part of the cell wall which has been removed.) *f*, dark coil of larval excrement, in the anterior of the two cells, lying in the concavity of the cell partition.

Stems chosen by this species have cavities typically between 3·0 and 4·0 mm. diameter. Borries gives 3·0–3·5 mm.; mine show extremes of 2·5 to 4·2 mm. Sometimes the cavities have already been tenanted by *Coelocrabro capitosus* (Shuckard), as for example nests M1 and M2 (Table I). In this event most of the debris from the previous occupation is packed closely at the bottom of the cavity before the construction of the new nest is begun. The number of cells may be nine, probably normally at least six, though in Denmark three to five per stem was the more usual. The length of the cells ranges from 7·0 to 11·5 mm. Those from which females emerge average about 1 mm. longer than male cells.

The cell-partitions are firmer and more specialised than in *P. atratus*. Though usually quite thin, they may be more than 1 mm. thick. As Borries first observed, the matter of which they are composed is finely

macerated pith moistened into a coarse pulp with saliva. He agrees with Giraud that they may closely resemble parchment. I can confirm this last statement with the qualification that the partition is viewed from the inner side. For the interior surface, which is distinctly convex, is smooth and parchment-like because it consists of a finely-spun agglutinated meshwork (reminiscent of the material of a burnet moth cocoon). It is clear that the wasp first constructs, with its own secretion, a thin diaphragm (fig. 3*b*) on which the rest of the partition of macerated pith is laid down (fig. 3*a*). When newly formed the partitions may be pure white, as in nests Q11 and Q18 (Table I), but they are liable to discolour with age. Borries observed that the pith for the partitions was taken from the adjacent wall, so that the cells were appreciably enlarged towards the inner end. I too have noticed this effect in a minor degree, but it is not general, and presumably depends on the availability of suitable pith. The whole nest may be closed by a stouter terminal plug of a similar type (*e.g.*, nest M1). Verhoeff (1891) stated that a fine covering of mud is given to the partitions, but this observation, already questioned by Bischoff (1927 : 201), is clearly erroneous.

The prey, in all instances observed, consists of Psyllid nymphs. Giraud found nymphs with four rudimentary wings, packed about twenty to a cell. Grandi confirmed this observation in a nest of three cells, which contained 23, 20, and 23 respectively. In my nest Q11 the first cell had a store of 16 ; in Q18 the first cell had 24, but the second only had 14, which were of considerably larger average size.

The translucent egg, seen in one cell (nest Q11), lay in the middle of the cell attached to an example of the prey. The larva, which is white, is briefly described by each of the authors mentioned. When fully fed it spins more freely than the larva of the preceding, but the structure of the incomplete cocoon is essentially similar. Laterally a more or less continuous thin lining is given to the wall of the cell. Anteriorly this lining merges into a firmer cocoon-cap, which is usually detached from the cell wall for a millimetre or two, and is more complete than in *P. atratus* (p. 138). But, as in that species, the main part comprises a solid terminal disc, concave on the inner side, and coloured a reddish-brown. It forms a secondary partition to the cell, and its remains persist long after the nest has been abandoned. Fig. 3 (*c*–*c*) represents a well-developed cocoon as it would appear with the pupa removed.

The final larval excrement, deposited at the bottom of the cell, survives as a firm black coil (seen in side view in fig. 3*f*).

Parasites.

None are recorded. The only evidence of them in my nests, which can at most have produced very few, was a single Tachinid puparium.

Other habits.

There seems little chance of finding adults in the field except round bushes close to nesting sites. Dr. Perkins informs me he took specimens round pine trees, in S. Devon, surmising that the wasps were attracted to resin.

PSEN Latreille.

Psen Latreille, 1796 (*sens. str.*); Richards, 1935, 1937 (*nec* André, 1886; E. Saunders, 1896; Berland, 1925).
< *Psen* Kohl, 1896; E. Saunders, 1906; Malloch, 1933; de Beaumont, 1937 : 40–45, figs. 3–9.
Dahlbomia Wissmann, 1849; Berland, 1925 : 132, figs. 230 and 239.
Mesopora Wesmael, 1852.
< *Mimesa* Dahlbom, 1843; E. Saunders, 1896; Dalla Torre, 1897.

In recent revisions of the Psenine wasps both Malloch (1933) and de Beaumont (1937) keep this group combined with the following genus (*Mimesa*), giving it subgeneric status. (The larger genus has then to take the name of *Psen*, as *ater* is the oldest genotype.) In spite of the fact that N. American representatives, for example, are less divergent from *Mimesa* than the single distinctive European species, I see better reason to follow Richards (1935, etc.) in regarding *Psen* (*sens. str.*) as a valid genus.

The genus is poorly represented in the Holarctic region, but is numerous and widely spread in the tropics. The sole species from western Europe, if *exaratus* (*superba*) may be disregarded as of doubtful status (see footnote, p. 131), is *Psen ater* (Fabricius) [? *compressicornis* (Fabricius)]. It has the following distinguishing characters, apart from the generic characters given above (p. 130).

Size large, *ca.*10 mm. Black, except in the male the following areas are reddish-yellow (in the female more or less ferruginous): scape and ventral surface of flagellum, mandibles, palps, anterior and intermediate tarsi, tibiae, and femora dorsally. Face densely clothed with silvery hairs in the ♀, ferruginous to golden hairs in ♂, and with a small tubercle between the antennal insertions. Petiole distinctly long, smooth, more or less flat dorsally, with hairs only on ventral surface. Propodeum with well-defined longitudinally rugose basal area. Male with apical setae of sternites 3 and 4 forming more or less distinct tufts which protrude ventrally; with scape much dilated, collar-shaped apically, completely enclosing segment 2; with flagellum dilated and compressed apically, segments 9 to 12 excavated beneath and serrate; and with joints 1 and 2 of tarsus 2 produced laterally, the basitarsus also with two acute spines at apex. Female with pygidium rather dull, impressed with scattered large piliferous punctures, and carinated laterally; and with tibia 3 densely spinose.

As a British species *Psen ater* is known only from specimens captured by collectors in the first half of the nineteenth century. According to Shuckard and Curtis, Kirby possessed several specimens, presumably from the Ipswich district, E. Suffolk. F. Smith took an example of each sex at Hawley, N. Hants, and mentions a specimen seen on a flower at Lowestoft, E. Suffolk.[2] There are three specimens, one male and two females, in F. Smith's collection, housed in the Hope Department, but these bear no labels.

Our knowledge of the biology of *Psen ater* is fragmentary. The earliest information refers to nesting in sand (*e.g.*, Schenck, 1857). Subsequent observations by Rudow (André, 1886 : 181) showed that nests may be constructed in dead timber, in disused galleries of wood-boring beetles; and this André was inclined to accept as the ordinary

[2] In addition, C. Blomer (1833) recorded "*Psen compressicornis*" from Bridgend, Glamorgan, but the specimen may have been simply a male of *Psenulus atratus* (Fabricius), which formerly sometimes passed under that name. See also Hallett (1928).

habit. Sickman (1892 : 97), however, confirmed that the species also nests in hard sand. It seems, therefore, that *Psen ater* resembles *Trypoxylon figulus* (L.) in utilising ready-made cavities both in wood and in the ground.

Rudow described the cells as slightly enlarged chambers at the end of a burrow of about 5 cm. length. When stocked these were closed with a plug composed of fragments of macerated wood. The prey in each consisted of four or five small nymphs (unspecified). The fully-fed larva was found to produce a complete, elongated, almost cylindrical cocoon, the shell of which was strong, opaque, and of reddish colour.

Sickmann (*loc. cit.*) found that *Macropsis lanio* L. (JASSIDAE) was taken as prey. One of the N. American *Psen* is recorded as apparently preying on *Aphrophora* (CERCOPIDAE), and another on *Acutalis* (MEMBRACIDAE) (Malloch, 1933), so that the genus can be said to select various Homoptera Auchenorrhyncha, including the larger forms.

MIMESA Shuckard.

Mimesa Shuckard, 1837 ; André, 1886 ; Berland, 1925 : 133–136, figs. 240, 241 ; Richards, 1935, 1937.
<*Mimesa* Dahlbom, 1843 ; E. Saunders, 1896.
>*Mimesa* Wesmael, 1852.
<*Psen* Kohl, 1896 ; E. Saunders, 1906 ; Malloch, 1933 ; de Beaumont, 1937 : 39–76, figs. 10–36.

Mimesa is the largest and most widely spread genus of the subfamily in the Holarctic region. Its species fall into two quite well-defined groups, treated as subgenera (see above key, p. 131).

The prey seems invariably to consist of small Homoptera Auchenorrhyncha belonging to JASSIDAE and related families.

Sex-difference.

In the male the seventh abdominal segment is usually not visible, and the sharply pointed eighth sternite usually protrudes, giving a superficial appearance of a sting-sheath. However, the males, which on the whole are smaller and slenderer than the females, are readily distinguished by the absence of a margined pygidium on tergite 6, though this tergite may be differentiated by its close puncturation. The 13-segmented antenna of the male is also rather more slender than the 12-segmented antenna of the female, and usually the more proximal flagellar segments bear weak carinae on their posterior surface.

Subgenus *Mimesa* Shuckard (*sens. str.*).

Aporia Wesmael, 1852 ; *et auctt.*
Psen, subgen. *Mimesa* Malloch, 1933 ; de Beaumont, 1937 : 54–76, figs. 21–36.
Psen, subgen. *Aporina* Gussakovskij, 1937.

The species of this group, with very few exceptions, have reddish colouring on the more anterior abdominal segments, and characteristically nest in the ground in light soils, excavating their own burrows.

Four are known to occur in Britain (all with red colouring), one of which has only recently been discovered. Specific determinations are critical, and a more detailed key than available hitherto has been felt necessary.

Among useful characters, differences in sculpture are essentially the most reliable, once appreciated. The relative length of the petiole is by no means constant : this part may be abnormally reduced in aberrant specimens. In the male the form of the antenna is diagnostic in each of our four species (fig. 4), if a clear view of the flagellar segments is obtained from an appropriate angle: Melanistic specimens are liable to occur, especially among small-sized males, but no instance is known of the abdomen being entirely black.

Males.

1 (2) Antenna flagellum distinctly long, segments 8 to 10 more than one and a half times as long as broad (longest nearly twice as long) (fig. 4*d*). Petiole clearly longer than postpetiole. Temples, in lateral view, half to two-thirds width of eye. (Legs, except tarsi distally, nearly entirely black. Antenna with flagellum segments carinated posteriorly as far as segment 7, but only very slightly rounded posteriorly in dorsal view, segment 8 with a weak tubercle, the last five clear.[3] Species scarce) *bruxellensis* Bondroit

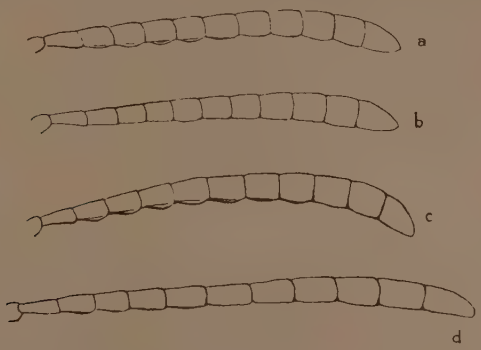

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FIG. 4.—Antenna flagellum of ♂ *Mimesa* (*a*) *equestris*, (*b*) *rufa*, (*c*) *shuckardi*, (*d*) *bruxellensis*, in dorsal view.

2 (1) Antenna flagellum of more normal length, segments 8 to 10 subquadrate or at least less than one and a half times as long as broad. Petiole at most a little longer than postpetiole, often shorter. Temples in lateral view, three-quarters or more the width of the eye.

3 (4) Mesopleuron very rugosely and closely punctured. Antenna flagellum simple : segments without carinae and none rounded posteriorly (fig. 4*b*). (Tibiae with pale markings, tarsus 1 entirely pale. Mesonotum closely punctured, the surface distinctly dull. Petiole shorter than postpetiole, usually broader

[3] Throughout this paper the antennal segments are numbered counting the scape as No. 1. In de Beaumont (1937), it should be noted, the numbers given in the same connection are intended to refer to the flagellum only, that is, they start from the second antennal segment. But, evidently in error, the numbering in the key to *Mimumesa*, and in figs. 15 and 16 on pp. 46 and 47, really applies to the whole antenna, not to the flagellum.

than in *equestris*, sometimes very short. Tergite 3 always black, tergite 2 more often black posteriorly than wholly red.)
rufa (Panzer) (*equestris* auctt.)

4 (3) Mesopleuron not so closely punctured that clear surface between the punctures is not plainly visible; punctures not rugose. Proximal flagellar segments bearing carinae and clearly rounded posteriorly in dorsal view.

5 (6) Legs with pale markings: tarsi and tibia 1 wholly or mainly pale. Petiole longer and narrower, at least as long as postpetiole, dorsally convex. Red on tergites often extending to tergite 3. In lateral view of head the temples are widest well above the equatorial line, so that the profile is markedly asymmetric. (Antennal segments bearing weak carinae as far as about segment 8; at least segments 4 to 7 clearly rounded posteriorly (fig. 4*a*). Mesopleuron only very indefinitely and sparsely punctured. Mesonotum punctures fine and not very close) . . . . . *equestris* (Fabricius) (*bicolor* auctt.)

6 (5) Legs black, except tarsi distally. Petiole shorter and broader, usually distinctly expanded posteriorly, shorter than the postpetiole, dorsally flat or even shallowly excavated. Tergite 3 always black. Temples widest at, or very near, the middle of the head in lateral aspect. (Antennal segments bearing carinae as far as about segment 10; segments 3 to 9 quite strongly rounded posteriorly (fig. 4*c*). Mesopleuron with numerous clear punctures. Mesonotum punctures stronger.) *shuckardi* Wesmael

Females.

1 (2) Antenna rather longer, with penultimate segments about one and a half times as long as broad, segment 3 quite four times as long as wide distally. Tubercle of clypeus very small and weak. In side view of head, temples narrower, two-thirds to three-quarters width of eye. Tergite 1 black anteriorly, and tergite 3 wholly black. Petiole clearly longer than postpetiole and basitarsus 3. (Petiole dorsally flat or very weakly convex, smooth. Mesopleuron with remote, fine, partially obsolete, punctures, finer than in *shuckardi*, but more distinct than in *equestris*. Mesonotum punctures somewhat firmer than in *equestris*. Legs black, except for tarsi distally) . . . *bruxellensis* Bondroit

2 (1) Antenna shorter, with penultimate segments only a little longer than broad or subquadrate, segment 3 about three times as long as wide distally. Tubercle of clypeus stronger or broader or both. Temples attain width of eye, or nearly so. If tergite 3 is wholly black, tergite 1 is normally wholly red. Petiole shorter than, or about equal to, the postpetiole.

3 (6) Tergite 1 entirely red. Petiole shorter than postpetiole, usually broadened distally, and more or less flat dorsally.

4 (5) Legs black, except for tarsi distally (and for a reddish spot at apex of tibia 3 near origin of calcar). Petiole flat dorsally, shining, but surface uneven with obsolete wrinkles. Mesopleuron with distinct, uniform, fine punctures, the surface between them more or less smooth but dull. Tergite 3 black. (Mesonotum with the punctures on the disc finer and more

remote, but stronger than in *equestris*. Tubercle of clypeus strong, but less broad. Second cubital cell normally less than half the third in area) . . . . . *shuckardi* Wesmael

5 (4) Legs with pale markings, especially on tibia 1, and usually at both extremities of tibia 2 and 3, the tarsi typically entirely pale. Petiole dorsally flat or weakly convex, shining and smooth along the middle, not uneven. Mesopleuron with punctures strong and numerous, the surface between them distinctly striato-rugose. Tergite 3 wholly red, or partially so for at least its anterior half. (Mesonotum with punctures stronger and coarser than in any of the four species. Second cubital cell about half area of third) . . *rufa* (Panzer) (*equestris* auctt.)

6 (3) Tergite 1 marked black anteriorly.

7 (8) Tergite 3 entirely black. Legs black, except tarsi distally *shuckardi* Wesmael (aberrant)

8 (7) Tergite 3 reddish, at least anteriorly. Legs with pale markings.

9 (10) Mesopleuron with strong and numerous punctures, the surface between striato-rugose. Petiole shorter than postpetiole, usually somewhat broadened posteriorly. Tubercle of clypeus broad but weak. (See also above) *rufa* (Panzer) (occasional specimens)

10 (9) Mesopleuron almost impunctate, even anteriorly. Petiole about same length as postpetiole, or slightly longer; parallel-sided. Tubercle of clypeus broad and strong. (Petiole dorsally convex—*i.e.*, possessing a low rounded median carina. Tergite 3 sometimes mainly black. Mesonotum punctures finer and more remote. Propodeum more coarsely sculptured than in other species except *bruxellensis*) . . *equestris* (Fabricius) (*bicolor* auctt.)

Mimesa equestris (Fabricius) (*bicolor* auctt.).

Trypoxylon equestre **Fabricius, 1805.**
Psen bicolor **Jurine, 1807; Kohl, 1896; E. Saunders, 1906; de Beaumont, 1937: 62-63, figs. 22, 31.**
Mimesa bicolor **E. Saunders, 1896.**
Mimesa equestris **Richards, 1935, 1937 (*nec prior. auctt.*).**

This is the most generally distributed of the four species, and often plentiful, though inclined to be local even where most numerous. Occurring throughout Great Britain, it becomes more local towards the north, and scarce in the extreme south-west. No black-and-red Mimesas are known from Ireland.

Specimens have been confirmed from the following vice-counties: W. Cornwall, S. Devon, N. Devon, Dorset, S. Hants, E. Sussex (*teste* O. W. Richards), W. Kent, Surrey, Berks, Oxon, Middlesex, N. Essex, Beds, W. Suffolk, E. Suffolk, W. Norfolk, E. Norfolk, Warwicks, Staffs, Cheshire, Caernarvon, Easterness (Nairn), S. Sutherland.

Published records, always under the long-standing name "*bicolor*," appear to be reliable to a high degree, and the following refer to additional vice-counties. E. Cornwall: Par, one ♀ (*J. Clark*). I. of Wight (*Morley*). E. Kent: Deal and Dover (*E. Saunders*). N. Lincs: Spilsby district (Graham, 1941). Notts: locally common (Carr, 1916). Glamorgan: at Porthcawl and Candleston (Hallett, 1928). Anglesey: in 1873 (*F. Smith*). Yorks: S.E. and S.W. (Butterfield and Fordham,

1932). CUMBERLAND: at Carlisle and Wan Fell (Routledge, 1933). AYRSHIRE: Irvine (*Malloch*).

The wasp occurs inland as freely as near the coast, and though definitely requiring a sandy soil, is able to colonise quite small patches of suitable ground in otherwise unsuitable areas, so that there is probably no vice-county on the mainland of Great Britain from which it is absent. At the same time its scarcity in some parts of southern England is not altogether explained by the lack of suitable soils. In W. Cornwall only a single pair has been taken (at St. Erth, 14.viii.27, coll. *A. Thornley*), and in E. Cornwall the one specimen mentioned above. In south-west Devon I have met with only a single "colony," which has been under periodic observation since 1933, in a small isolated patch of sandy ground in the Meavy Valley near Yelverton; while in other parts of S. Devon Perkins (1923) has noted the relative scarcity of the species. The N. Devon localities, Barnstaple, Croyde, and Braunton, are near together. In the south Cotswolds V. R. and R. C. L. Perkins never met with the species over a considerable period, and records from Gloucestershire and Somerset are still lacking. In north Dorset the two Dales, over a period of some seventy years, took only a single specimen.

This species often nests gregariously, the females excavating their own burrows in the ground. The site chosen may be on a slope or on level ground, where the soil is of firm sand, or of sand with some clayish admixture: it appears that the soil must be easily worked but not too loose. The mouths of rabbit holes and rabbit scrapes on sandy turf are often selected. Adlerz (1903) gives a short description of the burrowing habits: the excavated material is pushed upwards from below and, if the ground is level, collects in a crater-like pile round the hole; two burrows examined went vertically downwards for a short distance and then turned sharply in a horizontal direction. The mouths are left open when the wasp is away. Bouwman (1916 : 7) found the burrows 20 to 35 cm. long, apparently as a rule leading to two or three cells.

The prey consists of various species of JASSIDAE (*sens. lat.*), adult and nymph. Though many observers since Shuckard (1836 : 57) must have seen the wasps returning to their burrows carrying these hoppers, on very few occasions have any details of this behaviour, or identifications of prey, been recorded. Adlerz (*loc. cit.*) noted, as recent observations of my own confirm, that the hoppers are carried with their head forwards and ventral surface uppermost, held by the wasp's middle pair of tarsi directed backwards. Hoppers taken by Adlerz from a provisioned cell "showed no signs of life"; and no movements were elicited from specimens I took from wasps in transit. The number stocked in each cell is given by Bouwman (*loc. cit.*) as 12 to 20. Recorded identifications of prey are as follows:—

> *Tettigonia* sp. (F. Smith); *Deltocephalus collinus* Dahlbom, 1 male, 6 females, *D. abdominalis* Fabricius, 2 females, and *Thamnotettix sulphurellus* Zetterstedt, 1 female (Adlerz, 1903); *Grypotes punctifrons* (Bouwman, 1928); *Paramesus nervosus* Fallen, 5 males, 2 females, and *Athysanus sejugendus* Kirschbaum, 9 males, 10 females (Hobby, 1931).

With regard to the last species, Hobby found 14 of the 19 specimens, 7 of each sex, parasitised by a Dryinid (possibly of the genus *Anteon*), the black larval sacs of which protrude from the hopper's thorax ; and suggested that infected hoppers may be rendered more sluggish, and so fall easier prey to the wasp, than normal specimens. Of ten hoppers taken by me from *equestris* females on one occasion in 1940, four were found to be infected with Dryinid parasites (a male of *Prenanteon daos* (Walker)[4] was captured at the same site).

The following are new records of prey :—

Locality and date	Prey	Determined by	Observer
Queen's Bower, New Forest, 8 and 9.viii.08, 12.viii.09 and 16.viii.10	*Doratura stylata* Boheman, ♀	E. A. Butler	A. H. Hamm
	Jassurgus distinguendus (Flor) 1 ♂	,,	,,
	Macrosteles sexnotata (Fallen), 1 ♀, 2 nymphs	,,	,,
	M. horvathi (Wagner), 1 ♂	,,	,,
	Ophiola striatulus (Fallen), 4 ♀	,,	,,
	Thamnotettix cruentatus Flor, 4 ♂, 3 ♀	,,	,,
	Deltocephalus sp., ♂	,,	,,
	Jassid, nymph	,,	,,
Oxshott, Surrey, 14.viii.20	*Cicadula 4-notata* (Fabricius), ♀	O. W. Richards	A. H. Hamm
	C. sulphurella Zetterstedt, 2 ♀	,,	,,
Tubney, Berks, 5.viii.13	*Euscelis lineolatus* (Brullé), ♂	,,	,,
	Deltocephalus sp., 3 ♀	,,	,,
Oxshott, 6.vii.25	Jassid nymphs	,,	O. W. Richards
Netley Heath, Surrey	*Ribautiellus striatus* (L.)	B. M. Hobby	B. M. Hobby
Meavy Valley, S. Devon, 25.viii.40	*Euscelis* sp., 4 nymphs, 2 with Dryinid sacs (one with two sacs)	O. W. Richards	G. M. Spooner
	Ribautiellus striatus (L.), ♀	,,	,,
	Deltocephaline sp. nymphs	,,	,,
Puddletown Heath, Dorset 9 and 17.viii.26	*Euscelis lineolatus* (Brullé), 2 ♂, 2 ♀	O. W. Richards	C. D. Day
	Deltocephaline sp., nymphs	,,	,,

N.B.—The generic names have been brought up to date.

M. equestris is most in evidence in the later part of the summer, and first impressions might suggest that, as with its relatives and many other Sphecids, there is only a single annual generation. It seems, however, that in the south of England, at least, there are two broods : the first emerging about midsummer or a little later, and the second, much more numerous, from the end of July onwards. This conclusion

[4] I am indebted to Dr. O. W. Richards for confirming this identification.

has been reached from observations on the isolated colony in the Meavy Valley, S. Devon, particularly in 1940. Here the species normally appears during the second half of June (*e.g.*, in 1933 and 1945), in small to moderate numbers, chiefly males at first, and females more freely towards the end of the month. On June 30th, 1940 (a forward season), the males were already over, and females were stocking burrows ; they included some worn specimens. By July 28th fresh males had appeared in some numbers, but females were quite scarce, in a fresh condition, excavating burrows, but not carrying prey. Females were more plentiful on August 4th, when males were still numerous. On August 25th the stocking of burrows was in full swing, the population consisting entirely of females. These had already begun to decline in numbers by August 31st, and were quite over by September 15th. Data from July and

TABLE II. *Mimesa* (*sens. str.*)

Summarised dates of capture, in five-day periods.

	M. shuckardi		*M. bruxellensis*		*M. rufa*		*M. equestris*	
	♂	♀	♂	♀	♂	♀	♂	♀
June 3	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—
13	—	1	—		—	—	—	—
18	4	3	—	—	—	—	3	—
23	5	2	1	—	—	—	8	—
28	4	2	—	—	—	.	7	8
July 3	1	1	—	—	1	—	4	6
8	1	4	—	—	17	—	5	2
13	2	4	4	—	5	—	7	—
18	1	2	. 6	—	3	—	6	5
23	—	3	1	—	7	—	4	6
28	—	1	1	—	1	1	12	17
Aug. 2	—	1	—	2	—	—	6	21
7	—	2	—	-	1	5	4	13
12	—	2	—	—	1	4	4	18
17	—	1	—	—	—	3	4	19
22	—	—	—	—	—	—	—	4
27	—	—	—	—	—	-	—	8
Sept. 1	—	—	—	—	—	—	—	10
6	—	—	—	—	-	1	—	1
11	-	—	—	—	—	—	—	—
16	—	—	—	—	—	2	—	—
21	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	1
Total ...	18	29	13	2	36	16	74	139
Totals, months								
June	17	8	1	-	—	1	22	19
July	6	26	16	2	41	5	65	53
August	—	13	—	2	15	17	27	96
September	—	.		—	—	3	—	14
Total ...	23	47	17	4	56	26	114	182

Notes.—The date given in the left column is the middle date for the period. The sources of data are : specimens in the collections of the British and Manchester Museums, the writer's specimens and records, and a few from published sources. The totals in the lower part of the Table are higher owing to the inclusion of data for which the month only is available.

August in other years conform with those of 1940, except that in seasons when the weather is poor the species may last well into September. The figures provided in Table II give support to the view that *equestris* is double-brooded, since the spread of the dates for males over thirteen five-day periods is too great for a single-brooded species.

Early dates : male, June 18th, 1945 (Meavy Valley, S. Devon, three specimens), June 21st, 1922 (Cobham, Surrey, E.B.N., Brit. Mus. Coll., five specimens) ; female, June 27th, 1933 (Meavy Valley, two specimens). Late dates : male, August 17th, 1926 (Puddletown Heath, Dorset, one), August 18th, 1946 (Meavy Valley, one) ; sex not stated, September 7th, 1912 (Heathfield, S. Devon, R.C.L.P. MS. notes) ; female, September 24th, 1939 (Meavy Valley, one).

Flowers as a rule seem not to exert much attraction, but occasionally the species is recorded as swarming on them—*e.g.*, at *Conium* (Hallett, 1928), at *Torilis anthriscus* (Butterfield and Fordham, 1932), and at *Angelica* (G.M.S.). Single specimens of the male have also been taken at *Chaerophyllum* (Morley, 1899), *Pastinaca*, and *Heracleum* (G.M.S.). All the flowers concerned are umbellifers.

The habit, shared with some other Sphecids, of flying over bushes in an apparently aimless manner was observed at the Meavy Valley colony in 1940. The males, and to a much smaller extent the females, flew in numbers over bramble bushes, settling on the leaves quite as much as on the flowers; and persisted in doing so during August when the blossoms had been completely replaced by ripening fruit. Only occasional specimens were then noted at adjacent *Angelica* flowers. Curiously, the only time members of this colony have been observed visiting *Angelica* freely was on September 1st, 1946, after a heavy fall of rain, with foliage and ground still wet, and the population consisting entirely of females.

Parasites.

Species of *Mimesa* (subgenus) are parasitised by one, or possibly two, members of the Chrysidid genus *Notozus*. Though this assertion awaits indisputable proof, and details of the life-history of any *Notozus* are lacking, the circumstantial evidence is strong. There is still some confusion over the synonomy of European *Notozus*, into which it is not proposed to enter. It is, however, clear that there are two related species in north and west Europe which concern us here. One, *N. spina* (Lepeletier) [=*panzeri* var. (Fabricius, 1805) ; *panzeri*, Trautmann, 1927], probably associates with *Mimesa equestris* and *shuckardi* on the continent, but confirmation is needed (see Berland and Bernard, 1938). The other, *N. constrictus* Förster [=*panzeri* Buysson, and various authors, ? *nec* Fabricius, *nec* Trautmann ; *scutellaris* (Panzer) Berland and Bernard[5]], is more certainly a *Mimesa* parasite, and it is this species alone which occurs in Britain. It is apparently also this species which Schenck (1856) recorded as attacking *Mimesa equestris* (*bicolor*). At any rate in Britain this association probably holds, as believed by Morice (1903, and MS.

[5] If these authors are correct in their identification of Panzer's species, the name *scutellaris* should, strictly speaking, be adopted, since it antedates any others.

notes), and supported by some more recent circumstantial evidence. The Chrysidid, however, is more sporadic and local than *M. equestris*, even though it associates also with *M. shuckardi* and *M. rufa*.

Myrmosa atra Panzer (*melanocephala* auctt.) is another possible parasite (see Adlerz, 1903).

Mimesa rufa (Panzer) (*equestris* auctt.).

Psen rufa Panzer, 1805.
Mimesa equestris E. Saunders, 1896 ; *nec* Fabricius, 1805 ; *nec* Shuckard, 1837.
Psen equestris Kohl, 1896 ; E. Saunders, 1906 ; de Beaumont, 1937 : 66–68, figs. 25, 26.
Mimesa rufa Richards, 1935, 1937.

The habits bear a general similarity to those of the preceding. The range, however, is more restricted : within it distribution is more irregular ; and periodic fluctuation seems more liable. Specimens have been confirmed from the following vice-counties : S. Devon ; Dorset ; S. Hants (*teste* O.W.R.) ; Surrey ; W. Kent ; Bucks (*teste* O.W.R.) ; N. Essex : Berks ; Oxon ; E. Suffolk : W. Suffolk ; Cambs ; Northants ; E. Norfolk. *M. rufa* is known with certainty also from Glamorgan (Hallett, 1928) ; N. Lincs (*R. C. L. Perkins*, MS. notes ; Graham, 1941) ; and Notts (Carr, 1935).

The status in different areas varies considerably. Presence in Glamorgan, Cambs, and Northants depends on single records ; in Notts on three captures ; and in Dorset on less than ten. On the other hand, in some districts in favourable years it may abound, and outnumber *M. equestris*. For instance, in S. Devon R. C. L. Perkins (1923, and MS. notes) took it in several years at Dawlish, where it was particularly numerous in 1911 and 1912, and found it in some profusion in 1919 at Christow on the banks of the River Teign. In this part of Devon *rufa* is more plentiful than *equestris*, though quite local ; but I have never seen it in the south-west part of the county. In East Anglia it appears to be common locally from N. Essex to the south part of N. Lincs. Thus there are several examples, taken at different times, from the Colchester district in the Harwood Collection (British Museum, N.H.). In W. Suffolk several were taken by Tuck at Bury St. Edmunds, and the species seems particularly frequent in the Breck Sands country. In E. Norfolk it was found abundant by Bradley in July and August, 1900, at West Runton, where C. W. Dale took it in 1905 (specimens in Dale Coll.) ; and was recorded as not uncommon at Mousehold and elsewhere by Tuck (1902). In the Woodhall Spa district of N. Lincs it was first taken by Bowhill (Perkins, MS. notes), and found to be plentiful in 1939 by Graham (1941). In the Oxford district it occurs in both counties, and appears to have been taken freely at Shotover by A. H. Hamm. But in the south-eastern counties *M. rufa* has seldom been found in any numbers, even in the heath districts of Surrey and S. Hants, though a number of males were taken at Oxshott by Mortimer on July 6th, 1913 (British Museum Coll.).

Occurrence in S.W. Yorks is not unlikely, but there are no recent records to corroborate that of F. Smith, which must remain suspect. So certainly must another old record for S.W. Perthshire by McGregor

(Saunders, 1896). During last century there was still confusion over this species, even by E. Saunders himself in his earlier days.

Thus *M. rufa* seems to be absent from the west Midlands northwards, and to be confined south-eastward of a curved line drawn through the Humber, mid Wales, and west Devon. Within its range it is liable to be more abundant towards the periphery (Lincs and E. Norfolk -W. Suffolk—Oxon—S. Devon).

The summarised dates of capture shown in Table II point to a single annual generation, which in an average year emerges in early July. Male : end June (probably) to second week of August : extreme dates from available records : July 4 (1914, Tubney, Berks) to August 13th (1898, N. Essex). Female : in an average season probably mid July to end August ; extreme dates from rather scanty records : one June (1900, Bury St. Edmunds, Tuck. "6–00"), to September 7th (1902, Shotover, Oxon) and "mid September" (1886, Dawlish, S. Devon, R.C.L.P., MS. notes).

A study of British records leads to an impression of periodic fluctuation which is not apparent in those of the other species. For example, *M. rufa* seems to have occurred most freely in the periods 1899–1901 and 1911–1913. It is noteworthy that each of these periods was ushered in by an outstandingly warm and dry summer.

No special observations on the nesting habits have been made, but as far as is known these closely resemble those of the preceding species. *M. rufa* seems to be more intolerant of the driest sandy habitats ; and solitary individuals are encountered much more frequently. For the first time identifications of prey can be given.

Locality	Prey	Determined by	Observer
Queen's Bower, New Forest, 8 to 9.viii.08	*Euscelis plebejus* (Fallen), 1 ♂, 1 ♀	E. A. Butler	A. H. Hamm
	Thamnotettix cruentatus Flor, 2 ♂, 2 ♀	,,	,,
Ditto, 10 to 16.viii.09	*Macrosteles sexnotata* (Fallen), nymph	,,	,,
	Doratura stylata Boheman, 2 ♀	,,	,,
	Limotettix striola (Fallen), ♀	,,	,,
	Ophiola striatulus (Fallen), ♀	,,	,,
	Jassargus distinguendus (Flor) 1 ♂, 1 ♀	,,	,,
	Jassid nymph	,,	,,

Single specimens of the male have been taken at *Carduus arvensis*, *Heracleum*, *Pastinaca*, and *Angelica* ; and of the female at *Angelica* and *Daucus*.

The Chrysidid *Notozus constrictus* Förster (see p. 151) undoubtedly attacks this species, as suggested by Morice (1903) and confirmed by Perkins (1923). Dr. Perkins informs me that at Christow, S. Devon, the *Notozus* occurred in large numbers around the nesting sites.

Mimesa shuckardi Wesmael.

Mimesa equestris Shuckard, 1837 (*nec* Fabricius ; *nec* E. Saunders, 1896, etc.).
Mimesa shuckardi Wesmael, 1852 ; E. Saunders, 1896 ; Richards, 1937.
Psen shuckardi Kohl, 1896 ; E. Saunders, 1906 ; de Beaumont, 1937 : 63–65, figs. 23, 32.

Much restricted towards the east and south-east of England, this species is only at all common in sandy heath districts, nesting in exposures of bare sand. Specimens have been confirmed from the following vice-counties : Dorset ; S. Hants ; W. Kent ; Surrey ; Middlesex ; Bucks (*teste* O.W.R.) ; Berks ; Oxon (*teste* O.W.R.) ; E. Norfolk.

Other vice-counties from which records exist are : I. of Wight : (*F. Smith*) (Saunders, 1896), but confirmation required ; Notts : Langford Moor, one ♀, 11.viii.24 (Carr, 1935) ; N. Lincs : Raithby and Woodhall Spa (Graham, 1941) ; Yorks, S.W. : one recent record, near Leeds (Butterfield and Fordham, 1932), but confirmation desirable An old record from Bridgnorth, Salop (*T. A. Marshall*) (Saunders, 1896), must be regarded as extremely doubtful. The range of the species thus seems to be limited to the eastward of a line drawn from York to Weymouth.

M. shuckardi is most frequent on the Bagshot Sands of Surrey, Dorset and Middlesex (*e.g.*,Hampstead Heath), the Oligocene Sands of the New Forest, and the Lower Greensand of Surrey. Northward it appears to be locally frequent in East Anglia, in places where the Glacial drift is of a sandy nature, and on the Breck Sands. Disused sandpits and vertical banks of exposed sand provide the most favoured nesting sites, and "colonies" of considerable size may occur in such situations (*e.g.*, on Lyndhurst Common, vi.27). The blown sand of coastal dunes does not prove attractive. For instance, on Southhaven Peninsula only two single specimens have been recorded ; one of which had excavated a burrow in the vertical slope of a dune "blow-out."

Emergence is relatively early in the season, and there is clearly only a single annual generation (Table II). The males are on the wing from mid June to mid July (extreme available dates June 13th to July 17th), and the females normally from second half of June to early August (extreme dates June 13th to August 17th).

The nesting behaviour appears to be similar to that of *equestris*, though very little has been published on it. Adlerz (1906) observed a small colony, in Sweden, nesting in a bank of clayish sand : the wasps were carrying to their burrows small hoppers, which were held in just the same manner as described for *equestris* (p. 148) ; the burrows were found to be of similar type, running downwards at first and then bending sharply to the horizontal. Bouwman's (1916 : 7–8) observations also apply equally to both species (see above).

The prey, as far as is yet known, is again confined to the family Jassidae. Richards (1944) records two females each carrying a female *Oncopsis flavicollis* L., at Langley Park, Bucks, 20.vi.43.

The following are additional records for Britain :—

Locality	Prey	Determined by	Observer
Lyndhurst, S. Hants	*Macropsis virescens* (Fabricius), ♀	E. Saunders	A. H. Hamm
Matley Bog, New Forest	*Oncopsis flavicollis* (L.), ♀	E. A. Butler	A. H. Hamm
Hampstead, Middlesex, 12.vii.25	*Oncopsis flavicollis* (L.), ♀ *O. rufusculus* Fieber ♀	O. W. Richards ,,	O. W. Richards ,,
Oxshott, Surrey, 6.vii.25	*Oncopsis flavicollis* (L.), 2 ♀ *O. rufusculus* Fieber ♀ *Empoasca smaragdula* (Fallen) ♀	,, ,, ,,	,, ,, ,,

Copulation was observed on bare sand by Dr. Richards (Hampstead Heath, 2.vii.26).

In addition to the preceding species, *M. shuckardi* also is evidently parasitised by *Notozus constrictus* Förster, Morice (1903) finding the Chrysidid in abundance at a large colony of this *Mimesa* at Lyndhurst. The related *N. spina* Lepeletier is stated to attack it in Sweden (Berland and Bernard, 1938 : 29).

Mimesa bruxellensis Bondroit.

Psen sp. Hallett, 1928 : 51.
Mimesa sp. Bondroit, 1932 : 29–30.
Mimesa bruxellensis Bondroit, 1933 : 61.
Psen bruxellensis de Beaumont, 1937 : 65–66, figs. 24–33.

This species is distinguished chiefly by its longer antennae, a character particularly noticeable in the male.

In Britain it was first noted as a distinct species by Mr. Hallett and Dr. Perkins, the former having captured a few males on the Glamorgan sandhills (Hallett, 1928). In 1938 Dr. O. W. Richards captured a male at Southhaven, Dorset, which he recognised as belonging to *M. bruxellensis*, a species which had, in the intervening period, been described from Belgium (Bondroit, 1932, 1933). A search for overlooked specimens revealed 6 males and 1 female in my own collection, and Mr. Hallett's Glamorgan specimens were confirmed as this species by Monsieur J. de Beaumont. Altogether the following British records have come to light.

Dorset : Southhaven Peninsula, near Studland, 1 ♂ on bracken, 29.vii.38 (*O.W.R.*) ; 2 ♂, taken from a group seen flying over *Erica cinerea*, 17.vii.30, and 1 ♀ flying over a *Betula* bush, 2.viii.37 (*G.M.S.*) ; Bere Heath, 2 ♂ 11.vii.40, 2 ♂ 14.vii.40, 2 ♂ 17.vii.40 (coll. *H. L. Andrewes*) ; Warmwell Heath, 2.viii.47, ♀ in disused sandpit (*G.M.S.*). S. Hants : Beaulieu, ♂ 24.vi.11 (*G. le Marchant*) (Brit. Mus., N.H.). W. Kent : Darenth, 4 ♂ (*T. A. Marshall*) (G.M.S. Coll. ex V. R. Perkins Coll.). Surrey : Cobham, ♂ vii.08 (Brit. Mus., N.H.) ; Byfleet, ♂ and ♀ vii.13 (*C. H. Mortimer*) (Brit. Mus., N.H.) ; Oxshott, ♂ 25.vii.37

(*K. M. Guichard*). Glamorgan: Whitford Burrows, ♂ vii.21, Porthcawl, ♂ vii.26, ♂ vii.27 (*H. M. Hallett*) (Cardiff Mus.).

Dates of capture (Table II) indicate that it emerges rather later than *shuckardi*, but earlier than *rufa*.

The species is evidently much scarcer generally than any of the preceding, unless its headquarters have not yet been discovered. De Beaumont is able to refer only to very few specimens: three Belgium, one France, one Switzerland, and two (probably) Italy.

Subgenus *Mimumesa* Malloch.

Mimesa (*sens. str.*) Wesmael, 1852.
Psen, subgen. *Mimumesa* Malloch, 1933; de Beaumont, 1937: 45–53, figs. 10–20.
Psen, subgen. *Mimesa* Gussakovskij, 1937.

This section of the genus *Mimesa* is represented in Britain by two black-bodied species formerly recognised, to which a third is here added. Two additional species have recently been found to occur in Belgium, and the possibility of either occurring in this country is not to be ruled out.

Some well-marked differences exist between this group and the foregoing Mimesas (see above key), but within it the species are not, for the most part, separable on very conspicuous characters. Even *unicolor* and *dahlbomi* have been to some extent confused, but the amplified key given below should remove any difficulties which have hitherto existed. The two species lately described by Bondroit (1931, 1933) are included in the key, in order to facilitate the chances of their coming to the notice of collectors, should they, like *bruxellensis*, also occur on this side of the Channel.

As far as is known, *Mimumesa* do not nest in the ground, but occupy ready-made burrows in timber, rotten wood, and other types of cavities provided by the dead parts of plants.

Males.

1. Antenna slightly longer, distinctly slender,[6] more especially along its basal half. Petiole at least one and a third length of postpetiole. Mesopleuron impunctate, or almost so; and puncturation of head weak. (Species so far not recorded from Britain) . 2

   Antenna slightly shorter, flagellum gradually increasing in thickness towards apex, but base not notably slender. Petiole one to one and a quarter length of postpetiole. If mesopleuron is without a number of evident punctures, puncturation of head is firm and close 3

2. Antennal segments carinated as far as segments 10 or 11, the carina on segments 9 and 10 distinctly broader and more prominent (though shorter) than those on preceding segments. Fourth

[6] Mons. Bondroit (*in litt.*) calls attention to the more slender, or filiform, character of the antennae of *atratina* (*belgica*) and *littoralis*, pointing out that the difference is quite noticeable to the naked eye. This I can confirm with regard to *M. atratina*, with the reservation that only the basal half of the flagellum, rather than the antenna as a whole, shows this feature clearly.

segment of tarsus 2 somewhat elongate. (Stipes more or less rounded apically, without an apical process. Anterior carina of mesosternum as in *dahlbomi*. Petiole longer than hind tibia—of evident exceptional length—about one and a half times length of post-petiole) . . . *atratina* Morawitz (*belgica* Bondroit)

Antennal segments 3, 4, and 5 with a well-formed carina, the following segments, as far as 9, with reduced carinae, none of which are notably broad. Fourth segment of tarsus 2 about as long as broad at apex. (Petiole one and a third length of postpetiole, rather shorter than in *atratina*, but longer than in *unicolor*. Size apparently comparable with that of *unicolor*. Description from single specimen) . . . . . *littoralis* Bondroit

3. Anterior carina of mesosternum forming an angle in the median line (fig. 1*b*). Stipes produced apically into an elongate styliform process. In lateral view of head, temples broader than, or fully as broad as, the eye (ratio temple : eye = from 1·0 to 1·25). Median basal area of propodeum typically narrower. Antenna entirely black, never rufous at apex beneath. (Head rather closely and finely punctured. Carina of petiole typically more triangularly excavated. Scutellum typically more finely and less closely punctured than in *unicolor*. Antennal segments with carinae as far as segment 11 or 12. Tarsi testaceous) *dahlbomi* Wesmael

Anterior carina of mesosternum not angulated in the median line, but gently rounded (fig. 1*a*). Apical process of stipes short and blunt (fig. 5). Temples distinctly, or at least slightly, narrower than the eye (ratio temple : eye = 0·8 to 0·9). Median basal area of propodeum typically wider. Punctures of head, mesonotum, and scutellum either larger or more remote . . . 4

4. Punctures of head close and strong : no clear impunctate patches lateral to the ocelli. Antennal segments carinated posteriorly at least as far as segment 11, typically as far as 12 (the length of the carinae progressively reduced on 10 to 12). Apex of antenna beneath usually with more or less rufous colouring (sometimes absent, sometimes extending as far back as segment 10). Carina of petiole flattened for at least half its length, the flat part shallowly excavated and typically smoother. Pale colouring of tarsi brownish testaceous. Basitarsus 2 darkened at least centrally, sometimes entirely blackish. Sculpture of propodeum typically with closer reticulations . . . *unicolor* v. d. Linden

Head more finely and irregularly punctured, so that the surface in general appears more shining : on the vertex punctures more remote, small clear, almost impunctate patches of shining surface visible to the side of the posterior ocelli. Mesopleuron with rather fewer punctures. Antennal segments carinated only as far as segment 9 (occasionally as far as 10), so that the distal 3 to 5 segments are simple. (Typically the carinae extending the full length of segments 3 to 6, shortened on 7 to 9, and absent on the rest). Apex of antenna often entirely black, at most the last segment with reddish patch beneath. Carina of petiole flattened for about one-third of its length, the flat part usually much wrinkled. Pale colouring of tarsi 1 and 2 whitish or yellowish. Basitarsus 2 uniformly pale. Sculpture of propodeum typically with wider reticulations. Average size a little smaller **celtica** sp. n.

Females.

1. Pygidium narrow, shining, with prominent lateral margins and somewhat convex centrally; impunctate except for a lateral row of large shallow punctures on each side of the central area. Clypeus without dense silvery pilosity. In lateral view of head, temples distinctly wider than the eye (ratio=from 1·2 to 1·4). Carina of petiole clearly triangularly excavated (except at base), so as almost to be divided into two carinae which converge posteriorly. (Anterior carina of mesosternum distinctly angulated in median line. Clypeus with a distinct small central emargination. Mesopleuron with some sparse shallow punctures and posteriorly usually with shallow striate impressions. Antennae entirely black. Length 7–9 mm.) . . . . *dahlbomi* Wesmael

   Pygidium broader, of simpler form, flat, dull, punctured all over its surface, bearing short reddish tomentose setae which form a dense patch apically. Clypeus with silvery pilosity, sufficiently dense in fresh examples to obscure view of surface. Temples narrower (especially in *unicolor* and *celtica*). Carina of petiole not excavated, flattened to a varying extent 2

2. Mesopleuron smooth all over, without any evident puncturation under ×20 magnification. Pygidium less elongate. Posterior depression of propodeum more distinct. (Species so far not recorded from Britain) 3

   Mesopleuron with puncturation sufficiently evident under ×20 magnification. Pygidium more elongate. Posterior depression of propodeum shallower. (Anterior carina of mesosternum not angulated in the median line, but gently rounded—thus markedly differing from *dahlbomi*. In lateral view of head, temples scarcely wider than the eye (ratio from 1·2 to 1·0). Transverse facial carina connecting antennal insertions more obscurely defined than in *dahlbomi*. Clypeus scarcely perceptibly emarginate centrally. Petiole not longer than postpetiole, and shorter than tibia 3. Length 7–9 mm.) 4

3. Size larger (length 8 to 11 mm.). Puncturation of head rather stronger and more irregular (but finer than in *unicolor*). A distinct sublunate groove bordering the posterior ocelli. Scutellum posteriorly with the punctures more or less running into longitudinal striations. Pygidium (which is broader and less truncate apically than in *unicolor*) less obtuse apically. (Anterior carina of mesosternum as in *dahlbomi*. Petiole narrow, with a distinct carina, clearly longer than postpetiole by at least a third, as long as tibia 3. Antenna entirely black) *atratina* Morawitz (*belgica* Bondroit)

   Size smaller, apparently resembling *unicolor*. Head relatively shining, more finely and less irregularly punctured. Groove bounding posterior ocelli scarcely visible. Pygidium notably short and broad, its apical angle more obtuse. Scutellum with punctures irregular posteriorly, but not running into longitudinal striations. (Petiole apparently not longer than in *unicolor*. Description from single specimen) . . . *littoralis* Bondroit

4. Punctures of head close and strong: no clear impunctate patches lateral to the ocelli. Carina of petiole flattened for well over half its length. Pygidium with the dense patch of tomentose setae occupying at least its apical half. Sculpture of propodeum, latero-posteriorly, typically with closer reticulations *unicolor* v.d. Linden

Punctures of head finer and more remote, clear unpunctured patches evident on the vertex lateral to the ocelli. Carina of petiole only flattened over its basal half or third, the central crest evident for the rest of its length. Pygidium with smaller dense patch of reddish tomentose setae, which is sometimes almost completely suppressed, and at most occupies only the apical half or one-third of the length of the pygidium. Propodeum typically with wider reticulations. Average size rather smaller . . **celtica** sp. n.

Mimesa dahlbomi Wesmael.

Mimesa dahlbomi Wesmael, 1852; E. Saunders, 1896; Richards, 1937.
Psen dahlbomi Kohl, 1896: E. Saunders, 1906: de Beaumont, 1937: 51–52, figs. 11, 17, 20.

There has been some confusion in the past between this species and *unicolor*, to which it used often to be referred, although the difference in the female pygidium is very marked. The males, it is true, are more similar if the genitalia are not exposed, though a view of these separates the species instantly. Both sexes are further distinguished by the angulated anterior carina of the mesosternum, the wider temples, and certain minor differences in characters mentioned in the above keys.

A re-examination of local records has been necessary. I have seen the following specimens. S. Devon: Plympton, 3 ♀ 14.vii.35, ♀ 16.vii.35; Bickleigh Vale, ♀ 2.vi.40, ♂ 10.vi.47 (*G.M.S.*). N. Wilts: ♀ vi.15 (*P. Harwood*) (Wollaton Mus.). Dorset: Glanvilles Wootton, ♂ 27.vi.74 (*C. W. Dale*) (Hope Dept.)[7]; Warmwell Heath, 2 ♂ 19.vi.29, worn ♂ 24.viii.34; Weymouth, ♀ 23.vii.39 (*G.M.S.*); Powerstock Common, ♀ 27.v.44 (coll. C. D. Day); Lytchett, ♀ 29.viii.37 (coll. I. H. H. Yarrow) (Yarrow, 1938, as *unicolor*). E. Sussex: Eastbourne, ♀ viii.00 (*C. G. Nurse*) (coll. Cardiff Mus.). Surrey: Frimley, ♀ ix.07 (*Saunders*) (Brit. Mus.); Box Hill, 7 ♂ and 4 ♀ 1.vii.22 (*E. B. Nevinson*) (Hope Dept.); Byfleet, ♀ 9.vii.39 (*K. M. Guichard*). S. Essex: Benfleet, ♂ 18.vii.37 (*I. H. H. Yarrow*). N. Essex: Colchester (*W. H. Harwood*), ♂ (Wollaton Mus.), ♀ (coll. Nevinson, Hope Dept.). Herts: Brickett Wood, ♀ 1.vii.39 (*K. M. Guichard*). Middlesex: Highgate, ♀ 4.vi.22 (*Andrews*) (coll. I.H.H.Y.); Mill Hill, ♂ 17.vi.39, ♀ 10.vi.39 (*K. M. Guichard*). Berks: Bagley Wood, nr. Oxford, 2 ♂ 1.vi.29 (*G.M.S.*). W. Glos: Wotton-under-Edge, 2 ♂ (*R. C. L. Perkins*) (Brit. Mus.), ♀ 10.vi.84, ♀ 10.vi.85, 3 ♂ 1.vii.86, ♂ 2.vii.86, ♀ 8.vii.97, ♀ 10.vii.97, ♂ 16.vii.87, ♀ 1.viii.85, ♀ 10.viii.86 (*V. R. Perkins*) (coll. G.M.S.). Leics: Quorn, ♀ 20.vi.35 (*Saunt*) (Wollaton Mus.); Charnwood Forest, 9 ♀ 21.vi.to 16.viii.42 (*G.M.S.*). Notts: Bramcote, 2 ♂ 26.vi.31 (*H. P. Jones*). Westmorland: ♂ 9.vii.20 (*Britten*) (Manchester Mus.). Westerness: Fort William, 2 ♀ viii.39 (*K. M. Guichard*). Locality unknown:

[7] Recorded as *unicolor* (C. W. Dale, 1878; E. Saunders, 1896).

3 ♀ (Brit. Mus., N.H.), including E. Saunders' "type" of the ♀; 1 ♀, probably Dorset, Parley Heath or Charmouth (*J. C. Dale*) (listed and recorded as *unicolor*), 2 ♂ (coll. Dale, under *unicolor*, Hope Dept.); 1 ♂ and 1 ♀ (coll. Nevinson, Hope Dept.); 1 ♂, among *unicolor*, in coll. F. Smith (Hope Dept.).

Other localities from which *dahlbomi* has been recorded are as follows: S. Devon: Chudleigh, ♂ early June (Perkins, 1923); Bovey district (Perkins, unpublished). N. Wilts: Sopworth (Perkins, unpublished). S. Hants: New Forest (Arnold, 1905); Queen's Bower, New Forest, at burrows, 9 to 15.viii.06. (*A. H. Hamm*) (see p. 161). Berks: Wellington College (*Barnes*) (Hamm, 1906). Bucks: Burnham Beeches, ♀ bred, 12.vi.30 (*O. W. Richards*) (see p. 161). E. Suffolk: Parham Wood, several, *in coitu*, 12.vii.19 (*Vinter*), also 2.vi.31 (Morley, 1935). Worcs: Moseley (Bradley, 1900). Glamorgan: Cwrt-yr-ala, ♀ 7.vii.12, ♀ 14.vii.12; Old Cogan, ♀ 13.viii.21; Castell Coch, ♂ 4.vii.12 (Hallett, 1927). Notts: Border's Wood, Owthorpe, ♂ 11.vi.25 (*Jones*) (Carr, 1935). S.W. Yorks: Wakefield, two specimens bred (*E. G. Bayford*) (Butterfield and Fordham, 1932). Midlothian: Polton, 18.vi.01 (Evans, 1901). A record from Burnham, E. Somerset, is questioned by Perkins (1924). Certain other records published under "*unicolor*" should probably be referred to this species (see p. 163).

The period during which it is on the wing is somewhat extended for a single-brooded species, as nearly all British Mimesas appear to be, but this may not be exceptional for an aculeate living in wooded surroundings which may take varying times to warm and dry up in the summer: males, 27 records June 1st to July 18th, 1 record (a very worn specimen), August 22nd; females, 43 records, May 27th to August 31st, and 1 for September.

Though nowhere at all numerous, *dahlbomi* is evidently widely distributed over the mainland of Great Britain, occurring chiefly in wooded areas. It frequents dead and decaying timber, which, as shown by the observations summarised below, invariably provides its nesting quarters. Cells are provisioned in ready-made cavities, such as beetle galleries.

The earliest observations on nesting habits are those of Sickmann (1892 : 96), who found burrows in rotten wood in north-west Germany. Borries (1897) refers to it frequenting tree-stumps and woodwork in Denmark. But prior to this Dr. R. C. L. Perkins (*in litt.*) was acquainted with the species nesting in decayed wood in N. Wilts, and in dead beech stumps near Wotton, W. Glos. Adlerz (1906 : 33), in Sweden, found it nesting in rotten birch stumps lying on the ground, occupying, and to some extent adapting, old galleries of wood-boring beetles; as well as in a decayed aspen trunk, in which two cells were examined. Jansson (1919) again records the nest in a disused beetle gallery, this time under the bark of a dead pine. Specimens were once reared from an oak-beam, tunnelled by *Xestobium*, from Wakefield Cathedral, Yorks (Butterfield and Fordham, 1932). Further instances of nesting in dead tree-stumps are given by Arnold (1905) from the New Forest, and by Yarrow (1938, as *unicolor*) from Dorset.

Dr. O. W. Richards found a pupa, from which a female wasp emerged, in rotten wood under the bark of a pine stump, at Burnham Beeches, Bucks. In Charnwood Forest, Leics, in 1942, I observed females with burrows in the dead stumps of oak trees on three occasions. Other females were entering old beetle burrows in a rotten tree-trunk lying amongst grass on an open slope, 31.vii.42. On various other occasions, in Leics, Berks, Dorset, and S. Devon, I have taken examples at felled trunks and tree-stumps ; and once at the post of a fence.

As regards the prey, preference seems to be shown for DELPHACIDAE, but JASSIDAE are also taken. Sickmann (1892) recorded immature specimens of *Delphax* spp. Adlerz (1906) found very small hoppers (not identified) being stored, as many as 38 being packed in one cell : in transit these were carried in the wasp's mouth—*i.e.*, held by the mandibles and not by the middle legs. Jansson (1919) states that the contents of one of the burrows he examined consisted entirely of Delphacids of the genus *Liburnia*.

The following are the first British records to be published :—

Locality	Prey	Remarks	Determined by	Observer
Queen's Bower, New Forest, 9 to 15.viii.08	*Delphacodes fairemarei* Perris, 2 ♀	—	E. A. Butler	A. H. Hamm
	Do., 3 ♂, 15 ♀	Contents of one cell	E. A. Butler	A. H. Hamm
	Do., 2 ♂, 16 ♀	,,	,,	,,
	Do., 1 ♂, 18 ♀	,,	,,	,,
,,	*Delphacodes fairemarei*, 7 ♀ *Deltocephalus flori* Fieber, 2 ♀ *D. abdominalis* Fabricius, 3 ♀ sp. ? fragments, 1 ♀ Jassid, nymph, 2	,,	,,	,,
,,	*Delphacodes fairemarei*, 1 ♂, 6 ♀, 1 ? sex *Deltocephalus flori* Fieber, 1 ♀	,,	,,	,,
Burnham Beeches, Bucks, 15.v.30	Apparently mainly Delphacids	Remains of prey round cocoon	O. W. Richards	O. W. Richards

The cocoon was found by Richards to be made of soft wood.

Flowers are apparently not frequently visited. I have taken one male on *Angelica*, and one of each sex at *Euphorbia amygdaloides*.

Mimesa unicolor (Van der Linden).

Psen unicolor Van der Linden, 1829 ; Kohl, 1896 ; de Beaumont, 1937 : 47–49, figs. 10, 12, 16, 18.
Psen unicolor (*major pars*) E. Saunders, 1906.
Mimesa unicolor Wesmael, 1852 ; *et auctt.*
Mimesa unicolor (*major pars*) E. Saunders, 1896 ; Richards, 1937.

Though much more local than the preceding species, black *Mimesa* which have hitherto been correctly attributed to *unicolor* are sometimes quite numerous within limited areas. The exact status of *unicolor* in this country has, however, been obscure, owing partly to its general scarcity, partly to confusion with *dahlbomi*, and partly to its unobtrusive habits. The observations which it is so far possible to collate on "*unicolor*" leave much to be discovered.

In Britain the true *Mimesa unicolor* has its headquarters in, and is probably entirely restricted to, the south-east counties of England. A different form, described below as a new species, *celtica*, is restricted to sandhills in certain parts of west Britain and east Ireland. This new species is fully discussed below, and the data given at this point refer only to *M. unicolor* sens. str.[8] Its ascertained distribution is as follows :—

Dorset : heath districts in the south-east : Southhaven Peninsula, Studland, rather freely some years on a limited area of sandy heath with damp depressions, supporting growths of *Juncus*, patches of *Hydrocotyle*, *Anagallis*, etc., and with much litter of woody and other vegetable débris on the dry parts, specimens most easily secured by sweeping, occasionally seen flying on the open heath adjoining, ♂ July 11th to August 2nd, ♀ July 17th to September 19th ; Moreton, ♂ swept by Dr. C. D. Day, 19.vii.36 ; Parley Heath (*J. C. Dale*) (coll. Dale, Hope Dept.) ; Holt Heath (Boyd, 1942) ; Morden (*F. H. Haines*) (unconfirmed). S. Hants : New Forest (*Arnold*, *Jones*, etc.), recorded as fairly common (Jones, 1926). I have not examined any specimens from this area, but the locality seems a certain one in view of the occurrence in E. Dorset and Surrey. W. Kent : Tunbridge Wells, ♂ and ♀, —.vii.24 (*C. G. Nurse*) (Cardiff Mus.). Surrey : freely in the Bagshot Sands area—Chobham (*E. Saunders*), ♂ vi.76, ♀ viii.85, ♀ viii.92, ♀ viii.97 (Brit. Mus., N.H.), ♀ 4.viii.99 (Wollaton Mus.), ♀ viii.85 (coll. G.M.S. ex coll. V. R. Perkins) ; Woking (*E. Saunders*), 2 ♂ vii.88, 4 ♂ viii.91, ♀ vi.82 (Brit. Mus., N.H.), ♂ and ♀ viii.91 (coll. G.M.S. ex coll. V. R. Perkins) ; Woking (*Nevinson*), ♂ and ♀ 8.vii.06, ♂ 13.viii.05 (Hope Dept.) ; Byfleet, ♀ 2.vii.25, ♀ 10.vii.24 (*Pagden*) (coll. O. W. Richards) ; Horsell Sandpit, Woking, ♀ 16.viii.27 (*Pagden*) (coll. O.W.R.) ; Wisley, 2 ♀ 12.viii.36 (*I. H. H. Yarrow*) ; Oxshott, reported as rather common by Dr. Richards ; also recorded (but not confirmed) from Ripley by Morice, and from Holmwood by Mortimer (V.C.H. of Surrey, 1902) ; in the Lower Greensand district recorded by Mr. O. H. Latter (MS. notes) from Thursley Heath, 22.vi.20 and 14.viii.20, and from a heath near Godalming, 10.ix.07 and 18.vii.15, on the latter occasion visiting flowers of dodder (but identifications not confirmed).

[8] The subject, which is at present *sub judice*, of possible differences between British *unicolor* and the continental type is not dealt with here.

The species apparently also occurs in East Anglia, but records are few. W. Suffolk: Tostock, one in a marshy spot, 1902 (Tuck, 1903). E. Suffolk: singly at Shrubland and Monk's Soham (Morley, 1935). W. Norfolk: King's Lynn, 2 ex. in 1908 (Atmore, 1909).

Apart from those which refer to *celtica* (see below), other published records are to be rejected or, at most, considered extremely doubtful. Most of the older records fall within this category, and these include Darenth (*Shuckard*), N. Wales (*Walker*), Charmouth (*J. C. Dale*), which were made prior to the description of *dahlbomi*; Isle of Wight (*Marshall*); and Charlton (*F. Smith*), for which see below. C. W. Dale's records for Glanville's Wootton and Sidmouth have been disproved; the former is based on a ♂ *dahlbomi*, and the latter on a series of specimens which are not even Sphegids (specimens in coll. Dale, Hope Dept.). A record for Taunton, S. Somerset (*Charbonnier*) is questioned by Perkins (1924). Misidentification is strongly suspected with regard to Lyme Regis, W. Dorset (Nevinson, 1904), and Wicken, Cambs (Nevinson, 1916).[9] Records given for Notts (Carr, 1916 and 1935) appear to be in error: the late Mr. H. P. Jones informed me that no specimens existed in the Nottingham collection, but one or two *dahlbomi* had been placed under *unicolor* (the woodland habitat for two of the records also suggests the former species).

It thus appears that *unicolor* is restricted to the eastward of a line drawn from Weymouth to Cambridge and from there to the Wash, and that in the northern part of this area (north of the Thames) it is at best extremely scarce. There are no indications at all of its existence in S. Devon or Cornwall, or in the Midlands from Oxford northwards.

This species emerges later than *dahlbomi*: male, 1 record for June, 18 for July, and 13 for August; female, 1 record for June, 10 for July, 9 for August, and 1 for September.

So far no reliable information of the nesting habits in Britain exist. Nor is Dubois (1922) able to refer to any for Belgium, though the species is common in that country. What records exist are mostly suspect through doubt as to the true identity of the wasp involved. Thus Shuckard (1837) states that Walker took "*unicolor*" nesting in posts and railings in N. Wales, but this was very probably *dahlbomi*, then undescribed, since *celtica*, which represents *unicolor* in this region, has not this habit (p. 165). Schenck (1857) also records "*unicolor*" nesting in an old post, where it had adopted a disused burrow; but this perhaps may refer to another of the black *Mimumesa*.[10] There is no later evidence at all that wooden posts, or dead timber in general, exert any attraction for *unicolor*. F. Smith's observation (Saunders, 1896) of *unicolor* nesting in thatch at Charlton, W. Kent, is possibly reliable, but Smith did not recognise *dahlbomi*,[11] and it is curious that this habitat should not have

[9] Unfortunately no specimens could be found in Nevinson's collection.

[10] Though Schenck recognised two black-bodied species, it has been suggested that his *dahlbomi* was really the species now known as *atratina* (de Beaumont, 1937, as *belgica*). Scandinavian writers have assumed that Schenck's *unicolor* was *dahlbomi*.

[11] In Smith's collection (housed in the Hope Dept., Oxford) there were found under *unicolor*: 2 ♀, unlabelled, of *unicolor s.s.*, 1 ♂ and 2 ♀ from Barmouth, and 2 other ♀, attributable to *celtica* (see p. 164), and 1 ♂ *dahlbomi*.

been confirmed since. A second-hand record on the authority of du Buysson (see Berland and Bernard, 1938 : 99) of "*unicolor*" nests in the stems of vine plants is much more probably correct, and gives a suggestive clue.

E. Saunders was the first collector in Britain to encounter *unicolor* in any numbers, but he made no observations on nesting habits. Dr. O. W. Richards informs me that he is without information of its nesting habits at Oxshott, his specimens having been mostly secured round bushes. In its habitat at Southhaven, Dorset, I can only say that it is not attracted to the marram of adjoining dunes, nor apparently to the type of timber in which *dahlbomi* would nest, nor does it appear to occupy burrows in open patches of sand : it is possible that it occupies cavities or even crevices among the dead and dry plant remains, such as bases of burnt *Molinia* tufts, which occur freely over the area it frequents. The conclusion, therefore, is that *unicolor* does not occupy any of the more usual types of nesting-site, but one that is not at all readily discovered.

No records of prey exist.

As regards Chrysidid parasites, there are probably none in Britain, but *Chrysis succincta* L. var. *friwaldskyi* was reared from the nests in vine stems referred to above (Berland and Bernard, 1938 : 99.)

Mimesa celtica, sp. n.

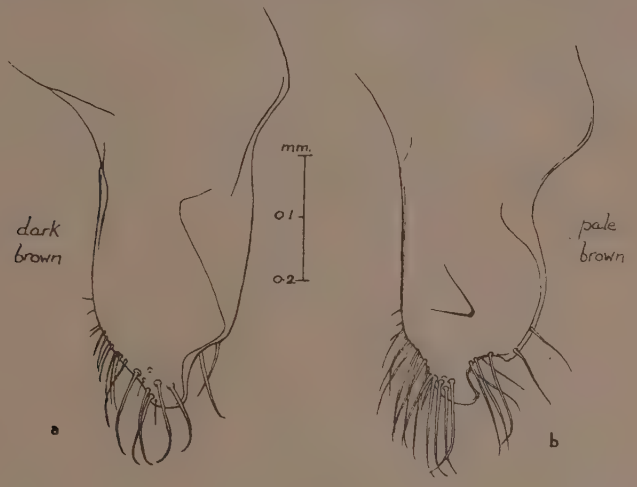
Mimesa unicolor (*in part*): E. Saunders, 1896 ; Richards, 1937.

The morphological characters (see keys, pp. 157-9) by which this species is separated from *unicolor*, to which it is clearly closely related, involve only small differences, but there appear to be sufficient of them to warrant treating *celtica*, which is in any case a distinct type, as a separate species. There is also a marked difference in the choice of habitat, which must carry with it some crucial difference in nesting habits, though these up to the present have not been ascertained.

Small differences probably also exist in the male genitalia. In fig. 5 the distal part of the gonostipes is figured, with a specimen of *unicolor* for comparison. In this example of *celtica* the structure is paler, its contours less rounded, its apical process less blunt, and its hairs a little longer and more numerous. Too few specimens, however, have been examined to show how constant these differences may be.

This is the species, recorded by various collectors as *unicolor*, frequenting sandhills on the coast of N. Devon, S. Wales, W. Wales, and E. Ireland. It has occurred as follows : N. Devon : Braunton Burrows, rather plentiful on marran dunes, both sexes 13.viii.33, 30.vi. and 1.vii.34 (Spooner, 1934), and again 3 and 4.viii.35. [N. Somerset : a record of a black *Mimesa* from Burnham suspected as this form by Perkins (1924) : the sandhills here have not been adequately investigated.] Glamorgan : common on sandhills at Porthcawl and in the Gower Peninsula (Hallett, 1928) (specimens of both sexes sent by Mr. Hallett have been examined). Merionethshire : coastal dunes : Barmouth (*F. Smith*), ♂ and 2 ♀ confirmed (coll. F. Smith, Hope Dept.) ; Towyn, vii.99 (Nevinson, 1900), series of both sexes confirmed (coll. Nevinson, Hope Dept.) ; Aber-

dovey, common, vii.04 (Mortimer, 1905); Pensarn sandhills, several 1.viii.02 (Bradley, 1902); Harlech, ♂ 8.vii.02 (*Yerbury*) (Brit. Mus., N.H.), confirmed. CAERNARVON: Criccieth, vii.00 (Nevinson, 1901). IRELAND: Dublin: North Bull, ♂ 7.viii.98 (*Halbert*), taken on dunes at the extreme north end of this area with *Crossocerus wesmaeli* (Lind.) (Stelfox, 1927)—this specimen, in Dublin Mus., has been examined. [Meath: Laytown (*Cuthbert*) (specimen not seen by Stelfox) (Stelfox, 1927.] Down: Newcastle (*King*), det. "*unicolor*" (R. C. L. Perkins, MS. notes). Locality unknown: 1 ♂ (Brit. Mus., N.H.) (possibly from Barmouth).



5

FIG. 5.—Distal part of gonostipes of (*a*) *Mimesa unicolor*, (*b*) *M. celtica*. Note that the difference in shape is partly, but not entirely, due to a slight difference in the angle of view.

M. celtica thus occurs in rather a restricted geographical area divided by the Irish Sea. If present in its sand-dune habitat it is not easily passed over: thus negative data have distinct value. It can be said that the species is almost certainly absent on the coast of Cornwall; also W. Gardner (1901) makes no mention of its occurrence on the Cheshire or S. Lancs. sandhills, and it has not been found in that area by later collectors. Its geographical range in the British Isles is probably completely known (assuming its occurrence on the Somerset coast), and so appears to be separated from that of *unicolor* by a distinct gap.

The characteristic sand-dune habitat of *M. celtica* has been studied at Braunton Burrows, where in 1934 the wasp was one of the most plentiful of any species of aculeate. The dunes here are very broad, with a wide seaward zone of undulating hillocks in which *Psamma* is dominant, and a flatter landward zone on which the sand is firmly settled

and which bears a varied flora. *M. celtica* proved to be almost confined to the outer part of the *Psamma* zone, being one of the first three species of aculeate (with *Pompilus plumbeus* Fabricius and *Tiphia femorata* L.) to colonise the most seaward ridges of all. It tended to concentrate in areas in which *Euphorbia* and certain other flowering plants, which both sexes visited freely, grew amongst the marram, the patchiness being extremely marked in 1935. The ground over which the wasps were flying was often unstable fresh blown sand. This type of habitat is not frequented by *M. unicolor* : there are no records at all of black-bodied *Mimesa* from the sandhills in the south and east of England. (Hayling Island dunes, where *Euphorbia* is plentiful, were visited in July, 1934, and the absence in this locality confirmed). *M. unicolor* occurs in inland habitats only, chiefly on the Bagshot Sand strata, and it is instructive to observe how it behaves where these strata abut on coast sandhills, which actually happens at Southhaven Peninsula, Dorset. Here the long ridge of marram dunes is devoid of both *celtica* and *unicolor*, but the latter occurs freely in a certain region on the edge of the Blown Sand area (at its narrowest part) where the vegetation is quite different (see p. 164). Only occasional specimens stray into the closely adjoining marram zone, though they may be swept from *Juncus* in depressions on its fringe. Clearly then there is some critical difference in habitat requirements between the two species.

The nesting site of *M. celtica* at Braunton Burrows could not be discovered, but here almost the only conceivable sites are those which could be provided by the marram itself. Both sexes of the wasp, especially the females, were seen to spend much of their time flying from one marram tuft to another, stopping at each tuft and investigating its base. The hollow rhizomes of this plant, which are often exposed by erosion of the surface sand, would supply the type of nest cavity required. Possibly the wasp often reaches these by penetrating at the base of a tuft, and so escapes from view.

Mimesa atratina Morawitz (*belgica* Bondroit).

Mimesa carbonaria Tournier, 1889 (*nomen. preocc.*).
Mimesa atratina Morawitz, 1891 ; Merisuo, 1933.
Mimesa belgica Bondroit, 1931.
Psen belgicus de Beaumont, 1937 : 49–50, figs. 11, 14, 19.

Of larger average size than other west European *Mimumesa*, this species has only recently been recognised as having a wide European distribution, from Finland to Italy, being common at least in Switzerland. In the past it appears to have been confused with *dahlbomi* rather than with *unicolor*. As it occurs in Belgium (Bondroit, 1931, 1933), there is yet a possibility that it may be found in Britain.

The characters given in the key are based partly on de Beaumont, and partly on information supplied by M. Bondroit. I have examined the male only.

Mimesa littoralis Bondroit.

Bondroit (1933 : 61 and 64–5) introduced this species on a specimen of each sex taken at Ostend in 1933. Beaumont (1937) does not include it in his key, and suggests (p. 53) that the two specimens may not belong to the same species. The reason for this is evidently because the original description was misread, since he quotes the petiole of the male being "longer than in *belgicus*" instead of "longer in *belgicus*."

M. Bondroit, however, has kindly supplied me with particulars of his two specimens, and it is clear from what he says that they make a pair, and evidently belong to a distinct species. In two respects the male agrees with that of *celtica*—the carination of the antennal segments only extends to segment 8 or 9 ; and the puncturation of the head, etc., is feeble. But both sexes of *littoralis* have impunctate mesopleura ; the male has slenderer antennae like *belgica*, and a rather longer petiole than *celtica* ; and the pygidium in the female is notably broad. M. Bondroit emphasises that *littoralis* is much more closely allied to *belgica* than to *unicolor*. If it is a coastal form it would be interesting to know how far its behaviour parallels that of *celtica*.

Appendix.

Choice of Prey related to Taxonomy.

Psenini : Hemiptera Homoptera.

(*a*) *Psen* : larger Auchenorrhyncha (Cercopidae, Membracidae, Jassidae (*Psen atra*)).

(*b*) *Mimesa* : smaller Auchenorrhyncha—

(i) *Mimesa* s.s. : Jassidae (*equestris, rufa, shuckardi*).

(ii) *Mimumesa* : Delphacidae (*unicolor*) ; Jassidae (*unicolor*, ? *atratina*).

(*c*) *Psenulus* : Sternorrhyncha—

(i) Aphididae (*atratus, fuscipennis*).

(ii) Psyllidae (*concolor*).

. *Habits related to Taxonomy.*

Mimesa s.s. : Prey carried ventrally, held by middle legs. Burrows excavated in purer sandy soils (*shuckardi*) ; various sandy soils (*equestris, rufa*).

Mimumesa : Prey carried in mandibles (*dahlbomi*).

Nests in ready-made cavities in wood (*dahlbomi*, ? *atratina*) : ? dry plant stems, or crevices near ground (*unicolor*) ; ? marram stems, on ground level (*celtica*).

Psen : Nests in ready-made cavities in wood or sandstone (*atra*) ; in plant stems (some N. American species).

Psenulus : Prey carried ventrally, held by middle legs (*atratus*).

Nests in ready-made cavities above ground level in timber and plant stems alike (*atratus*) : in plant stems almost exclusively (*concolor*).

Variation in the number of hamuli in the subgenus Mimesa.

Counts of the number of hamuli borne by the hind wing are recorded below, following a practice introduced by Dr. Richards, who has kindly supplied the data from his own specimens for inclusion. In the large majority of specimens (including all those from the British Museum and Manchester Museum) both right and left wings were taken into account, and when the number in the two wings differed the mean value was entered. This explains why halves appear among the figures.

Species		Total	Number of hamuli 5	6	7	8	9	10	11	Mean	S.E. of Mean	σ
M. shuckardi	♂	62	—	11½	39½	11	—	—	—	6·99	± 0·077	0·607
	♀	62	—	–	8	49	4	1	—	7·97	± 0·065	0·511
M. equestris	♂	100	1	13½	48½	33½	3	½	—	7·26	± 0·079	0·785
	♀	122	—	—	8	59½	47	7	½	8·45	± 0·066	0·724
M. rufa	♂	76	—	1	39½	29	6½	—	–	7·54	± 0·077	0·674
	♀	34	—	—	½	10½	18½	4½	—	8·79	± 0·118	0·688
M. bruxellensis	♂	12	—	—	2	8	2	—	—	8·00	± 0·17	0·60
	♀	3	—	—	—	2	1	—	—	(8·3)		—

The mean number of hamuli increases significantly from *shuckardi* to *equestris* to *rufa* to *bruxellensis*, that of the female being some 1·0 to 1·25 higher than that of the male. The higher variability of *equestris*, as shown by the value of σ, has claims to significance if the values of the two sexes are appropriately combined ; indeed a difference between the first three species with the progression *shuckardi—rufa—equestris* is beginning to emerge.

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